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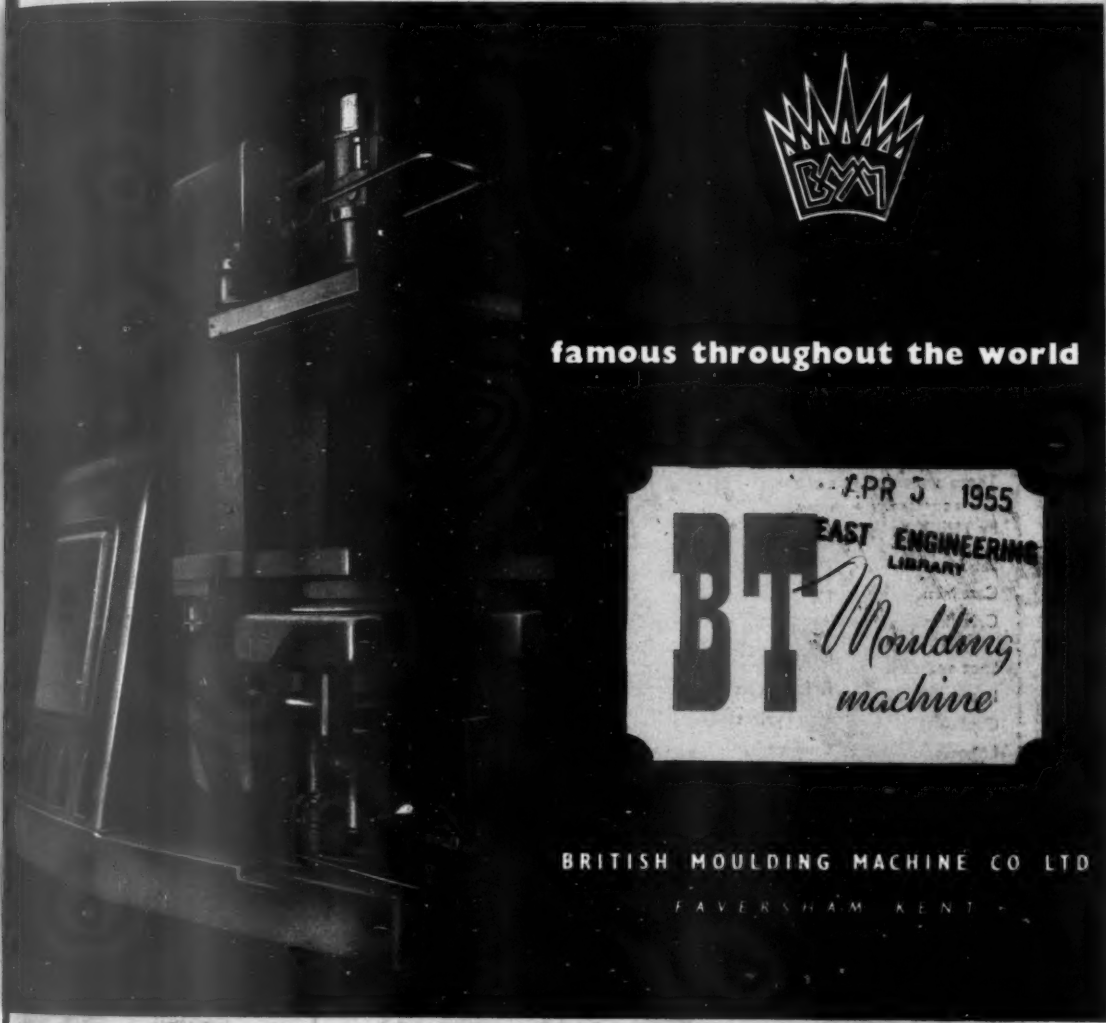

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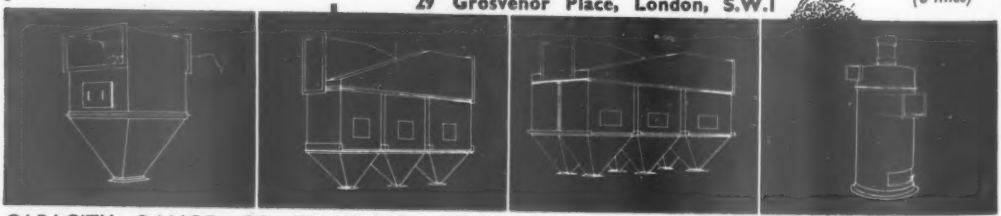

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IBF Proceedings, 1954*

The yearly issue of the "Proceedings" of the Institute of British Foundrymen provides the best possible opportunity of evaluating the technical progress of the industry which the Institute serves so efficiently. The first impression gained from each volume is the great variety of interests covered, both practical and academic. In the 1954 "Proceedings," just received, it is a far cry from pattern-making to the "Estimation and Influence of Gaseous Elements in Cast Iron" or from "Pinhole Porosity in Brass and Gunmetal Castings" to the "Production of Heavy Steel Castings." Yet it must be conceded that this diversity typifies the problems of the industry. Naturally enough, each section of founding desires the Institute to be the forum for the discussion of its own peculiar problems, and it is interesting to see how this works out.

The new "Proceedings" contains 15 papers dealing with practical and theoretical aspects of iron casting; eight others are of equal interest to all the sections of the industry; four are devoted to non-ferrous subjects; two to steel and one each to malleable and patternmaking. Exceptionally, there is no contribution to the study of light alloys. Such an analysis, however, is not strictly fair, for whilst an author on the subject of shell moulding may be dealing mainly with one foundry alloy, his subject matter is largely applicable to many others. This issue is of added interest as it contains the papers presented on the occasion of the Institute's Jubilee celebrations. They are contributions which will be consulted by foundrymen yet unborn. It is coincidental, yet appropriate, that the Jubilee Award should have been won with a paper on shell moulding—one of the more recent developments.

The "Proceedings" open with an account of what surely must be one of the Institute's most successful conferences. It was held in Glasgow under the presidency of Mr. John Bell, who in his Presidential Address gave a lead to the industry on the design of castings, which has since been enthusiastically taken up and a sub-committee has been formed to study the subject. The new volume has been splendidly edited by Mr. George Lambert and we have no hesitation in stating that—on the grounds of good presentation and the outstanding character of the matter contained—it warrants the designation as the best volume so far published. It does credit to the Institute and to the industry.

* Volume 47; published from the offices of the Institute, St. John Street Chambers, Deansgate, Manchester, 3.

Birmingham Shell-moulding Meeting

Mr. J. L. Rice addressed a small audience at the Birmingham Exchange and Engineering Centre on March 3 on the subject of shell moulding. His lecture followed the lines of his "Interim Report on Shell Moulding." The meeting was arranged by the Association of Bronze and Brass Founders.

Points that arose in the ensuing discussion concerned the economics of shell moulding, the problem of warped castings, and the best types of patterns to use. On the first point, Mr. Rice said that introduction of the technique must be approached realistically; it was unwise simply to take a specific object made by casting in ordinary moulds and compare the costs involved with those of the same object made by the shell process. A broader view must be taken. The shell-moulding method had great potentialities.

On the problem of warped castings, he said that warping arose from uneven curing. It was essential to get an even cure. Much depended on what kind of casting was being made. With a small job it was relatively simple to prevent warping, but with a heavy casting it was advisable to adopt some supplementary means of stiffening the shell. Ramming them up in sand or reinforcement in some way might be necessary; there was no universal method that could be laid down. A pattern could be built up in sections, the shell made and the parts broken up afterwards for subsequent re-assembly for castings.

Answering a question as to whether it was better to cast horizontally or vertically, Mr. Rice said that the tendency was at present to cast horizontally and only to cast vertically if the other way was impracticable. There was a possibility of roughness at the bottom of the casting with the vertical method, owing to hydrostatic pressure.

Discussing patterns, a Member stated that experiment had clearly shown patterns in cast iron to be by far superior to others, but it was generally agreed there was some advantage in aluminium patterns, notably ease of cleaning and the fact that the pattern-plates could be pressure cast. However, there was a risk of damage to aluminium patterns which had projections.

Irish Ironfounders' Merger

Effecting the merger of A. H. Masser, Limited, Dublin, and Waterford Ironfounders, Limited, Masser-Waterford Ironfounders, Limited, has been registered. The new holding concern has an authorized capital of £60,000 6 per cent. £1 preference and £200,000 in 5s. ordinary shares.

Holders of five 6 per cent. preference in Waterford Ironfounders get six preference in the holding company and for every four 5s. ordinary shares five ordinary in the new undertaking. For every five 7 per cent. preference in A. H. Masser the exchange is six preference in the holding company, and six ordinary for every 25s. of A. H. Masser ordinary. Full acceptance would mean an issued capital of the holding company of £52,050 preference and £158.500 ordinary shares. The accounts of the holding company will be made up from date of incorporation to June 30 next.

As THE JOURNAL goes to Press, the death is announced (on March 16) of Mr. G. W. BOOTH, managing director of Tyseley Metal Works, Limited, Birmingham. His obituary will be printed next week.

Correspondence

TEES-SIDE APPRENTICE COMPETITION

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—As secretary of the competition committee organized by the Tees-side branch of the Institute of British Foundrymen, I have been asked to issue a report for publication of the details of the above competition.

Owing to the wide-spread interest shown in the apprentice competition in this area last year, it was decided to organize a further competition this session. The interest is even greater, and has resulted in a total entry of 127 apprentices from 26 firms, as against 118 entries from 25 firms last year—in the four classes, namely: patternmaking, steel moulding, non-ferrous moulding and cast-iron moulding.

The competition has reached the stage when all the exhibits have been made and assembled at the Darlington Forge, Limited, for judging on March 16. The committee has been fortunate in obtaining the services of the same judges as last year, who all live outside the area. They are Dr. C. J. Dadswell of English Steel Corporation, Limited, Sheffield, who is a past-president of the Institute (for the steel section); Mr. F. Hudson, F.I.M., of the Mond Nickel Company, Limited, London (for the non-ferrous section); Mr. G. W. Nicholls, of Modern Foundries, Limited, Halifax (for the cast-iron section), and Mr. L. Brown, F.Inst.D., M.Inst.B.E., of the Premo Pattern Company, Limited, Birmingham (for the patternmaking section).

The prizes for the three best exhibits in each section will be presented at the annual general meeting of the Tees-side branch, on April 15. It is hoped that all interested in this competition will attend on that evening, to inspect the entries and assess their quality, at Head Wrightson's, Limited, Teesdale Hall, Thornaby.—Yours, etc.,

T. HURST, C.G.I.A., M.I.B.F.

Darlington Forge, Limited,
Darlington.
March 8, 1955.

Industrial Relationships Course

A sessional course in personnel management for students who intend to specialize in problems of human relationships in industry or closely related fields is to be run by the Department of Economics and Social Science of the University College of South Wales and Monmouthshire, Cardiff, in co-operation with the Department of Industrial Relations. Applications will be considered from candidates who are graduates of British universities, holders of social science diplomas, or older men and women over the age of 24, with a satisfactory academic background, nominated by their company to take the course, or wishing to enrol on their own initiative.

Latest Foundry Statistics

According to the Bulletin of the British Iron and Steel Federation, employment receded slightly as at January 8 in the steelfoundry industry as compared with December 4, 1954. For at the latter date it stood at 19,847 and at the former 19,701. The weekly average output of steel castings during December was 5,900 tons, which is 200 tons higher than that for the whole year. Multiplying the average weekly production by 52, it gives 296,400 tons for 1954.

Melt-quality Tests for Copper-base Alloys*

By A. R. French, A.I.M.

(*Continued from page 257*)

ALUMINIUM-BRONZES

The aluminium-bronzes are used for their high strength, resistance to fatigue and corrosion, and for their properties at elevated temperatures. The precise composition with regard to aluminium, iron and manganese contents, and whether or not the alloy should contain nickel, is decided according to the service requirements: it is essential that the most suitable composition for the service should be selected, and that the alloy should be carefully made and cast under proper metallurgical control.

Ingots

With these alloys satisfactory alloying is of paramount importance. The copper, iron, and nickel if any, are usually charged and alloyed, and the aluminium is then added. The possible faults are incomplete alloying of the copper, iron and nickel, and incomplete mixing of the aluminium. It is possible to introduce gas in the making of ingots, particularly if fluxes are used, but this is not necessarily important if the metal is to be subsequently remelted for casting. It is also possible during this stage for impurities to be introduced. Other possible faults are the loss of aluminium and the introduction of excessive iron from foundry tools.

Castings

From the point of view of foundry technique, these alloys are similar to the high-tensile brasses. They are of relatively short freezing range, up to about 45 deg. C.; it is important to ensure directional solidification by the use of adequate feeders and chills where necessary, and to ensure freedom from turbulence during pouring, as these alloys are liable to form oxide in the mould. Again, it is the case that if the foundryman is properly acquainted with the technique necessary for making castings in these alloys, the task is straightforward and usually responds to logical treatment, but there remains the need for the proper metallurgical control of the alloy.

In remelting the alloy for the manufacture of castings, it is possible to pick up impurities and to lose aluminium. It is also possible to pick up gas, particularly if a flux be used, or if the metal be melted in large quantities, that is, in such a furnace as a reverberatory furnace (with the flame in contact with the surface of the metal) as distinct from crucible melting. Dissolved gas can be removed by bubbling nitrogen through the metal: this can be a routine procedure or an estimation can be made of the gas content before pouring—this is the course frequently adopted in the case of very large castings, when large melts of metal are involved.

Melt-quality Tests

For the determination of the gas content of aluminium-bronzes, the reduced-pressure test is used, applying the fact that a tenacious oxide film forms over the surface of these alloys during solidification, and that this film is not readily permeable to dissolved gases when they are evolved during solidification. If, therefore, a sample be taken and allowed to solidify under reduced pressure (20 mm. mercury) as any gas present comes out of solution it will cause the head to rise: the fact that the metal has solidified under reduced pressure will cause the effect to be much more accentuated than if it were allowed to solidify under atmospheric pressure. Whether or not there is extensive gas present is estimated from the appearance of the surface of the specimen. The equipment developed by the British Non-Ferrous Metals Research Association is shown in Fig. 7 in which the vacuum pump reservoir and chamber can be seen; the more up-to-date equipment without the reservoir and also diagrammatically is shown in Fig. 8.† Typical examples of specimens from gassed and gas-free metal are shown in Fig. 9. (This technique should not be necessary with crucible melting and good melting practice.) If it is indicated that the metal is gassed, then it is necessary either to pour the metal into ingots for remelting or to de-gas with nitrogen and repeat the test.

Sand- and Fracture-bar Tests. As a pre-casting test for assessing the quality of the melt, the fracture-bar technique described for the high-tensile brasses can be employed. In this case, it is the colour of the fracture which indicates the amount of aluminium present. The sand-bar technique, also as already described, can be used as a pre-casting method if a large melt is involved and the half-hour waiting time can be tolerated. It is, however, also valuable as a check test after casting. A very close estimation of the aluminium content can be made from the appearance of the microstructure. In the nickel-free alloys, the iron-rich phase can be clearly seen, and in the case of the nickel-containing alloys a general check can be made as to the presence of the iron and nickel, although this is not very precise quantatively. The typical microstructure of BS1400 AB1 is shown in Fig. 10 (a) and of BS1400 AB2, the complex alloy, in Figs. 10 (b) and (c). The most suitable

* Paper read before the London branch of the Institute of British Foundrymen; subsequently also to the Beds. and Herts. section. The presentation was in each case accompanied by the showing of two short films.

† This equipment is manufactured and supplied by W. Edwards & Co. (London), Limited, Manor Royal, Crawley, Sussex.

FIG. 7.—*Original apparatus, developed by the British Non-Ferrous Metals Research Association for the reduced-pressure test.*

etchant for these alloys is that described by Alexander.*[3]

Used for the purpose of checking ingots, the sand-bar technique will clearly disclose incomplete alloying and the presence of impurities such as silicon and lead. As in the case of the high-tensile brasses, sand-bars, fracture-bars, or both, cast at the beginning and end of the pour will enable a check to be made on the efficacy of mixing the aluminium. Tensile tests and chemical analyses are the normal checks made after casting aluminium-bronzes. They do not, however, necessarily indicate the presence of improperly-alloyed material, or of impurities which can be there but which are not normally looked for. Again, the sand-bar test is a very valuable check in the hands of an experienced metallurgist.

COPPER/TIN ALLOYS

This section includes the tin bronzes, phosphor-bronzes, and lead bronzes, alloys used for their wear resistance and bearing properties, characteristics which depend upon composition and suitable microstructures. It also includes the straight gunmetals and leaded gunmetals which have good corrosion resistance and reasonable strength, and which find application for pressure-tight castings, backing castings for white-metal-lined bearings, and for general purposes where the strength is adequate. The lead-free gunmetals are used particularly for their corrosion resistance and strength which properties are associated with composition and structure, and while the corrosion resistance and strength of the leaded gunmetals also depend upon composition and structure these alloys are also selected for their particular suitability for casting.

In service, the success of all the alloys of the group hinges on composition, but equally importantly on structure and soundness, which are features influenced by the characteristic ease with which gas is dissolved by the molten metals, the long freezing-ranges of the alloys—varying from 150 to 400 deg. C—and mode of solidification. The factors which might be checked by melt-quality tests are gas content and composition, but the factor which is probably equally important but more difficult to control is mode of solidification.

As far as is known, there is no melt-quality test widely used prior to casting, and the discussion of the problem involved in this connection will form a main part of this section. Melt-quality is normally judged on mechanical-test results, but test-bars in these alloys can present considerable problems, arising principally from the influence of dissolved gas and mode of solidification: this subject will also be discussed in some detail.

Ingots

The tin bronzes and gunmetals are relatively easy to alloy as virgin metals, and there is not the necessity for the close metallurgical control which has to be exercised in the case of the high-tensile brasses and aluminium-bronzes. It is regarded as of paramount importance by the more reputable founders that high-grade gear and bearing alloys for more onerous duties should be prepared from virgin metals. These can be checked only after casting by chemical analysis and mechanical tests. The "sand-bar" technique already described can be employed for more frequent checks than would be feasible by analysis, and can be used for quick and reliable results. Frequently ingots are not made and the castings are poured directly after alloying, in which case a standardized microstructure test is of considerable value.

There is little doubt that a large proportion of the copper/tin alloys, particularly the gunmetals, now melted in foundries are purchased as secondary ingots, and clearly the need arises for close control in the ingot manufacturer's works over the quality of the metal introduced into the metal. Unfortunately, little knowledge is available on the influence of impurities such as antimony, sulphur and silicon, and certainly even less is known about the effects of combinations of these elements. There is indeed a need for considerable investigation into the effect of impurities on gas content, mode of solidification and mechanical properties. In view of the various ways in which impurities can possibly influence sand castings, it is important that the ingot manufacturer should make such melt-quality tests as will ensure that the metal, properly handled, will give satisfactory results in the sand foundry. It is indeed difficult to think of a suitable test which could be applied prior to pouring.

Castings

It is not possible in this paper to consider in detail each type of alloy within this group. According to statistics[4] recently published, 30 to 35 per cent. of the total output of all copper-base alloy castings is

* Composition of etchant: Acetic acid (75 per cent. aq.) 30 ml; nitric cid (conc.) 20 ml, and acetone 30 ml.

in the leaded gunmetals, and as they are affected typically by the influence of dissolved gas and by mode of solidification they will be considered here as representative of the group: they are commonplace alloys cast in most bronze foundries from the smallest to the largest. Alloys of this group have been used throughout the ages, and they, and particularly more recently the leaded gunmetals, have been regarded by foundrymen as alloys in which castings could be made with relative facility, as compared with the high-tensile brasses and aluminium-bronzes, which were introduced by specialist foundries little more than half a century ago and have necessitated considerable metallurgical study and control from their introduction. Founders of gunmetal castings have, however, not been free from their difficulties, usually in the form of sporadic outbreaks of trouble, particularly castings leaking under pressure and test-bars failing to meet specification requirements: troubles due to unsoundness or porosity which arise from the long freezing ranges of these alloys, and the readiness with which they dissolve gas. In relatively recent years, therefore, these alloys have received more attention from the metallurgist, and it is probably true that most of the effort has been focussed on the influence of dissolved gases.

Melt-quality Tests

American Fracture Test[5 6 7]

The leaded gunmetals are used very extensively in the USA and many investigations have been carried out concerning them. At the University of Michigan work was sponsored by the American Foundrymen's Society to develop a melt-quality test: a test which could be made before pouring the metal. This work was primarily concerned with 85/5/5/5 gunmetal, but later the conclusion was reached that the test developed for that alloy was also applicable to 88/8/4[7] gunmetal (and, therefore, presumably, to the range of gunmetals used in this country).

It was first necessary to define melt quality, and the authors of the first report on the work at Michigan quoted a definition by G. H. Clamer,[8] published in 1946, as follows:—

". . . if it is agreed that melt quality and melt composition are synonymous, then melt quality is determined by three factors:—

(1) The composition of all the raw materials placed in the charge, including the flux, if any.

(2) The contamination of the charge during melting, and while superheating to the pouring temperature, and contamination while transferring and pouring the melt into the mould cavity, including possible contamination of the melt in the mould cavity itself.

(3) The treatment to which the metal in the pot is subjected. This treatment is normally designed to remove—partially or completely—harmful impurities, especially the dissolved gases."

They decided, however, that for their work they would accept that melt quality would be evaluated on the basis of tensile strength, elongation and density. In the second report,[6] they wrote:—

"The term 'high melt quality' has come to mean 'Melts which are so low in deleterious gas contents and other impurities that the metal, as it is poured from the pot, is capable of producing superior castings, if the moulding sand and gating be correct.' It is necessary, therefore, that a quality test be one which will evaluate a metal with respect to gas content."

Initial Experiments

In the initial work,[5] the tests were carried out on test-bars cast to the standard American pattern designated "L.T.B.-2" (a modification of B.208-46.T Fig. 3) (Fig. 11) and on flat plates 2 by 6 in., varying from ¼- to 2-in. thick (Fig. 12). The metal was melted in glazed clay/graphite crucibles or in a magnesia-lined 3,000 cycle induction furnace, being melted in each type of furnace under oxidizing and reducing conditions. The charges were 100 to 170 lb. in weight and consisted of 50/50 ingot and scrap. The analyses quoted for the ingots used were within a surprisingly small range:—

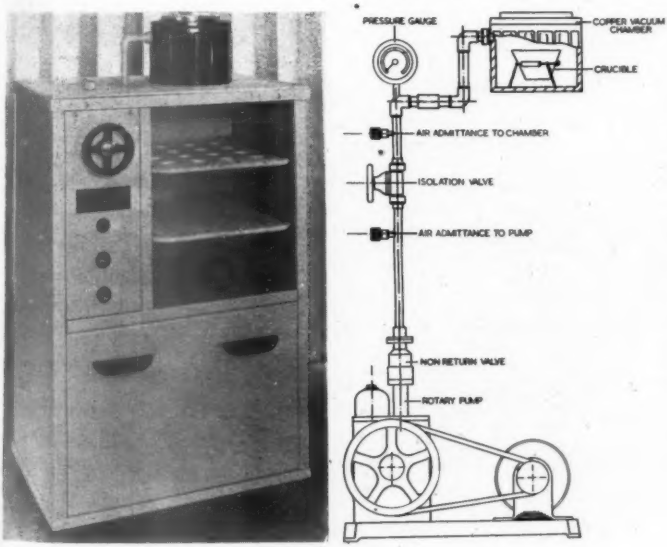


FIG. 8.—(*left*) *Modern form of the reduced-pressure-test apparatus and* (*right*) *diagram showing the construction of the apparatus.*

	Per cent.
Copper	84.06 to 84.91
Zinc	4.74 to 4.82
Tin	4.80 to 4.85
Lead	4.58 to 4.64
Nickel	0.57 to 0.58

(Attention is drawn to the deliberate addition of ½ per cent. Nickel.)

It was concluded that there was a correlation between the density, or the density and the tensile properties, and the appearance of the fractures of the test bars: Low quality was associated with fractures showing sharply-defined grey rims, with ragged red-brown or tan interiors; intermediate quality was associated with fractures showing poorly-defined rims with smoother red-brown to red-grey interiors, and high quality was associated with fractures showing no rim effect, but a striated pattern in a uniform faint red-grey structure. It was found that melts gassed by late contact with a source of moisture, and poured at a low casting temperature, showed fractures with a mottled, yellow-white interior.

For the purpose of reducing the time taken by the test so that it would be suitable for practical purposes, the investigation was developed[4] using a plate pattern ¾ by 3 by 6 in., cast in a vertical plane with a face ¾ by 6 in. chilled at the base with a cast-iron chill 1½ by 5¼ by 12 in. (Fig. 13). The plate was cast through a specially-designed pouring basin with two ½-in. dia. gates into the top face. The same melting equipment and methods were used, and again the charges were 50/50 ingot and scrap, using ingots of the same composition. The procedure which was devised and which takes only three minutes to carry out, is as follows:—

(1) Superheat to the final peak temperature according to the practice selected.

(2) Pour 4 lb. of metal into a No. 2 crucible containing 2 gm. 15 per cent. phosphor-copper (for deoxidation) and 18 gm. zinc (1 per cent., to compensate for melting losses).

(3) Pour the test-piece.

(4) Allow to cool for 1½ min., which will bring the temperature to approximately 820 deg. C. at 1-in. from the chilled face.

(5) Water quench and fracture.

(6) Examine.

TABLE I.—*Mechanical Properties and Fracture Characteristics of* 85/5/5/5 *Gunmetal Melts.*

Melt No.	Melting furnace.	Pouring temp., deg. C.	Melt quality.	Tensile-bar properties. Tensile strength tons per sq. in.	Elongation, per cent. on 2 in.	Density.	Fracture characteristics. Depth blue-grey.	Grain size* blue grey.	Depth columnar.	Hue.†	Oxide inclusions.	Degree‡ of mottle.	Colour of mottle.	Grain size§, upper part of bar.
22B	Gas ..	1,175	High ..	17.2	31.5	8.75	2	1	1½	3	Y-1(2)	3	Gold-yellow	2
29A	Induction	1,175	High ..	17.1	31	8.80	2	1	1	2	Y-1	2	Gold-blue ..	3
29B	Induction	1,120	High ..	17.0	32	8.84	1½	2	½	1	Y-2	1	Blue/yellow	2
30A	Induction	1,140	High ..	17.7	37	8.87	2½	3	½	1	Y-1	1	Blue/gold ..	2
35A	Induction	1,170	High ..	18.1	34.5	8.90	2½	1	1½	1	Y-2	—	—	1
37A(1)	Gas ..	1,170	High ..	16.9	35.5	8.88	2½	3	½	1	Y-3	1	Blue/gold ..	3
46A	Induction	1,180	High ..	16.8	31	8.84	1½	1	1½	3	Y-1	2	Gold/blue ..	3
48A	Induction	1,115	High ..	17.1	30	8.9	2	3	½	1	Y-1	1	Blue/gold ..	3
49A	Induction	1,165	High ..	16.6	31.5	8.85	1½	2	1	2	Y-1	2	Gold/blue ..	2
53A	Gas ..	1,150	High ..	17.0	30	8.87	2½	2	½	1	Y-1	—	—	2
31A	Induction	1,175	Inter**	15.8	25.5	8.77	1½	1	1½	2	Y-1	3	Gold/silver	2
38B	Induction	1,170	Inter ..	16.0	27.5	8.82	2	3	1½	1	Y-1	1	Blue/gold ..	1
44B	Induction	1,095	Inter ..	16.6	25.5	8.96	1½	3	½	1	Y-3	—	—	3
47C	Induction	1,065	Inter ..	15.9	26.5	8.78	1½	2	½	2	Y-1	1	Blue/gold ..	1
54-4	Gas ..	1,180	Inter ..	15.8	25.5	8.78	1½	2	1½	3	Y-1	3	Gold/silver	3
26A	Induction	1,175	Low ..	16.8	22.5	8.85	1½	4	½	1	Y-1	1	Blue/gold	2
32B	Gas ..	1,150	Low ..	15.4	20	8.65	1½	3	½	2	Y-1	1	Blue/gold ..	3
34A	Induction	1,230	Low ..	11.5	14	8.46	½	3	—	2	Y-1	3	Gold/blue ..	4
42A	Gas ..	1,170	Low ..	15.4	24.5	8.67	½	4	½	2	Y-1	3	Gold/blue ..	4
45-10	Induction	1,150	Low ..	16.5	24.5	8.86	1½	4	½	1	Y-1	3	Gold/blue ..	4

(1) Upper face chilled by pouring basin.
(2) Y-1—Yes, limited degree of oxides.
* Rated—No. 1, very fine; No. 4, very coarse.
‡ Rated—No. 1, no mottle; No. 3, heavily mottled.
† Rated—No. 1, very blue; No. 3, reddish.
§ Rated—No. 1, fine; No. 4, very coarse.
** Intermediate.

The following characteristics of the fractures were described:—

Zone Adjacent to the Chilled Face.—Fine-grained and of blue/grey colour with a superimposed columnar pattern extending from the chilled face to varying depths depending on the quality, but less extensive than the blue/grey fine-grained zone which also varied in depth with melt quality: the higher the melt quality, the greater the extent of the blue/grey zone and the columnar pattern.

Zone Remote from the Chilled Face.—A reddish-grey granular fracture associated with high quality. A mottled fracture, red-brown or yellowish spots in a reddish granular fracture indicated medium or low quality.

TABLE II.—*Summary of the Data of Table I.*

Quality gradings.	Density, gm. per c.c.	U.T.S., tons per sq. in.	Elongation, per cent.	Depth of Blue-grey zone, in.	Depth of Columnar zone, in.	Degree of mottle.*
Low	8.46–8.86	11.6–16.7	14 –24.5	¼–1½	Nil–½	1–2
Intermediate	8.77–8.96	15.8–16.6	25.5–27.5	1–2	¼–1¼	1–3
High	8.75–8.90	16.5–18.1	30 –37	1¼–2¼	¼–1½	1–3
Low	8.86	16.5	24.5	1¼	¼	3
High	8.84	17.0	32.0	1¼	¼	1

* No. 1 no mottle. No. 3 heavily mottled.

It was concluded[6] that melt quality could be correlated with the fracture, and that with high-quality metal there would be at least two inches of the fine, blue/grey structure, and ¼-in. of columnar structure. With lower quality, the columnar structure of the blue/grey zone would be less and the remainder of the fracture would change in appearance as described. The fracture characteristics were found to be independent of the pouring temperature within the range 1205 to 1095 deg. C., the chill-block dimensions, the core-mould composition, the shake-out temperature, the notching of the chill block to facilitate the fracturing of the test-piece, and the furnace used or the melting practice.

Study of Results

It is interesting to study the results on which these conclusions were based: (see Table 1). It is unfortunate that single test-bar results are quoted, as there is no indication of the scatter between bars from the same melt, but it should be noted that the diameter of the cast test-piece is considerably smaller than that of the bars frequently cast in this country. A summary of the results is shown in Table II: there is some complexity in correlating the fracture characteristics with the properties, and it is unfortunate that the association of the depths of the blue/grey and columnar zones with the quality gradings cannot be readily reconciled with the conclusions drawn. The most definite association with the classification of quality is to be found in the elongation values. The two individual results shown below the double line in Table II are of interest: with knowledge of the inconsistency which can arise from bars cast from the same heat, it would be invidious to reject the metal graded as "low quality," or to persuade the foundryman to apply some treatment to elevate it to "high quality." It is noted that the correlation between the fracture characteristics and gas content, which was originally regarded as "necessary," has not been achieved. From a study of the results reported, it would appear that the differences in the fracture characteristics, on which judgment would have to be based in using the test, are not nearly sufficiently marked for the test to be regarded as a satisfactory one.

British Trials

The members of the Productivity Team which represented the bronze- and brass-founding industry became aware of this work while they were in America and fully reported the details of the technique[9] on their return to this country: many trials were carried out in British foundries, but the Author knows of no record which shows that the foundrymen were able satisfactorily to correlate melt quality as judged by density- or mechanical-test results, with the appearances of the fractures. Two series of trials have been carried out by the Author, and, more recently, a series of the American fracture test-pieces has been cast with production melts with which DTD bars made in inhibited green-sand moulds were cast for density determinations. The characteristics described have not in all cases been found in the fractures, and when they have been found there has been no satisfactory correlation between density and appearance of the fracture. One of the major difficulties which has been encountered in British tests, probably surprisingly, is that in normal production melts leaded gunmetal is rarely found to be gassed to a significant degree: in fact, in order to produce gassed metal for the purpose of the tests it has been found necessary to introduce hydrogen deliberately.

Influence of Gas

In this country, extensive work has been done by W. A. Baker and his colleagues at the British Non-

FIG. 9.—*Typical examples of gassed and gas-free metal, after applying the reduced-pressure test and sectioning.*

Ferrous Metals Research Association[10]. They have studied the effects of freezing shrinkage and dissolved gases, and have demonstrated the efficacy of oxidation/reduction treatments and scavenging methods for degassing, including the use of nitrogen. Work has followed to study gas absorption in moulds, leading to an understanding of metal/mould reaction so that the gas content of the metal could be controlled, and introduced in such a way as to influence favourably the distribution of porosity in the castings. Pioneer work in this field has also been done by Pell-Walpole[11], who gave particular attention to the oxidation/reduction technique for improvement in the quality of chill-cast tin bronzes.

As a consequence of the long freezing ranges of these alloys, a network of dendrites forms during solidification, and the feeding of the almost isolated liquid metal between the arms of the dendrites must take place through the interstices between them. Feeding of thinner sections occurs from a heat centre of a casting which might itself be isolated from a mass supply of liquid metal resulting in a concentration of porosity at the heat centre with possible consequent leakage on pressure test. The evolution of gas during the later stages of solidification of the

TABLE III.—*Summary of Comparative Results from Various Types of Test-bars (Casting Temperature, 1,160 deg. C.)*

Type of bar.	Density, gm. per c.c.	U.T.S., tons per sq. in.	Elongation per cent.
IBF pattern .. .. (3 separate bars)	8.66	17.2	20
	8.64	16.0	19
	8.66	16.3	20
Eash pattern .. .. (4 bars together)	8.59	15.6	19
	8.53	11.9	10
	8.56	13.1	13
	8.54	12.4	10
Triple bar .. .. .. (3 bars together)	8.60	15.2	21
	8.51	10.7	8
	8.64	15.5	19
BNFMRA pattern .. .. (2 bars together).. ..	8.67	15.3	16
	8.64	14.4	15
	8.65	16.9	23
	8.69	15.4	16

thinner sections reduces the feeding from the heat centre so that a casting is obtained with porosity distributed more favourably as regards pressure-tightness. There is little doubt that for this reason the presence of gas dissolved during melting, which was usually carried out under charcoal, enabled foundrymen to make satisfactory pressure-tight castings throughout the ages. The amount of dissolved gas, which introduced by this means has been a variable, can now be brought under control by the use of oxidation/reduction techniques, or by nitrogen de-gassing followed by the introduction of a controlled amount of phosphorus to produce the desired amount of gas by metal/mould reaction: it is claimed by the BNFMRA investigators that gas introduced by this means is more effective in ensuring the desirable distribution of porosity.

As far as the gas content of the metal in the mould is concerned, therefore, the important factors are the amount of gas dissolved in the metal in the furnace, the amount of gas which can be picked up during transferring the metal from the furnace to the mould, the phosphorus content of the metal which will produce mould/metal reaction, and those other factors which can influence mould/metal reaction—casting temperature, whether the mould is " green " or dry, the permeability and moisture content of the sand, and whether a supposedly dried mould is in fact properly dried.

Pressure Tightness

Foundrymen have known for a long time that in order to achieve the best results with pressure-tight castings it is desirable that machining should be kept to a minimum. A probable reason for this has been shown by Cibula[12], of the BNFMRA, who has demonstrated that the columnar grains which grow from the mould surfaces provide a sound skin for the casting, and that the equiaxed internal structure due to the pasty mode of solidification is porous. It follows, therefore, that if the columnar surface is removed by machining then the chance of the casting leaking under pressure test is considerably increased. There is no doubt that mode of solidification is a critical factor in the production of pressure-tight castings.

Mechanical Properties—Test-bars

Mode of solidification is also of prime importance when strength is required. The casting most commonly made in which it is required to have satisfactory mechanical properties is the test-bar, as this is used as a criterion in the inspection of the metal, it being required to demonstrate that the metal is capable of giving certain minimum mechanical properties: this is, therefore, a melt-quality test. With high-tensile brasses and aluminium-bronzes, there has been little difficulty in obtaining representative results and from any melt three test-bars can be cast which will give consistent results. With the copper/tin alloys, however, test-bars have been a major problem, first, in the difficulty of obtaining mechanical-test results truly representative of those which the alloy is capable of giving, and second, in achieving consistency between results of bars cast from the same heat. As test-bars are used for a melt-quality test, it is not inappropriate to consider in some detail the factors which influence consistency in test-bar results.

Test-bars are simple in design and are therefore castings which it should be possible to make under consistent and strictly controlled conditions. The IBF bar is well known to all foundrymen*: consists of a shaped test-piece with a feeder at each end, and is usually poured down one of these feeders: a form of this bar is shown in Fig. 14(a), the shape of the test portion having been modified. More recently, the " triple bar " has been introduced and is illustrated as a recommended pattern in BS 1367[13]: three shaped test-pieces are connected

* First described by the Non-Ferrous Sub-committee of the Technical Committee of the BF at the Glasgow Conference in 1936.[14]

together at each end into a central feeder, sometimes poured down one feeder and sometimes through a separate ingate: a version of this bar is shown in Fig. 15. The feature of the triple bar is the attempt to economize in the weight of metal necessary to produce three bars. Another pattern designed to produce a number of test-pieces as economically as possible—probably more well known among light-alloy foundrymen—is the Eash-pattern bar, which provides four test-pieces linked in the form of a square, with feeders at the corners and with a central downgate, a version of the test-bar with slightly modified choked ingates at the corners is shown in Fig. 16. The BNFMRA has also developed a type of test-piece in which two bars are situated parallel to one another in a horizontal plane connected to a central feeding block. The drawback to this particular pattern is that it provides only two test-pieces, and as it is normally required to have available three bars, two sets would have to be made.

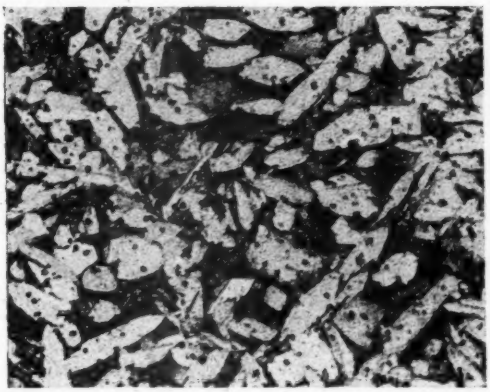
The IBF bars, the Eash-pattern bars, and the triple bars have been tried out under production conditions for extensive periods. Series of comparative tests have been made and a typical set of results is given in Table III. All the results quoted to illustrate the points made in this Paper have been obtained with 86/7/5/2 gunmetal, with a theoretical density of 8.91 gm. per cc., cast in green-sand moulds.

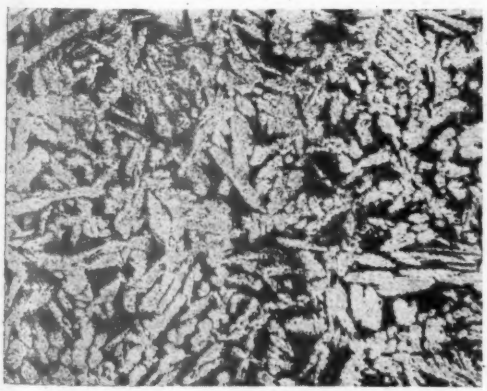
Consideration of Results

It is to be observed first that none of the density results was high, and, apart from the Eash-pattern bars, which show slightly lower values than the rest, the densities are reasonably consistent. On the other hand, the mechanical-test results of the IBF bars show a reasonable consistency in the range 16 to 17 tons per sq. in. and elongation 20 per cent.; none of the Eash-pattern bars comes up to this level, although one result is reasonable, two are very poor, and one might be described as intermediate; the triple bar gave two reasonable results and one very poor result; the BNFMRA bars, of which two moulds were cast, showed results which were reasonable to good. All these bars were made in normal green-sand moulds.

The results shown by the Eash-pattern bars and the triple bars are quite typical in that it is not at all abnormal in the case of a triple bar to have one good result and two poor results, or *vice versa*, it is not abnormal when using the Eash pattern to obtain a varying number of good results and a complementary number of poor—or even very poor—results from the same spray: typical results are shown in Table IV. On the other hand, while the IBF bars cast in groups of three as three individual bars give results which are more consistent than the other patterns described, and, on the whole, at a higher level, the degree of inconsistency is still frequently excessive.

When pouring metal for the normal IBF bar down one of the feeders without using care, it is quite possible that there is considerable turbulence





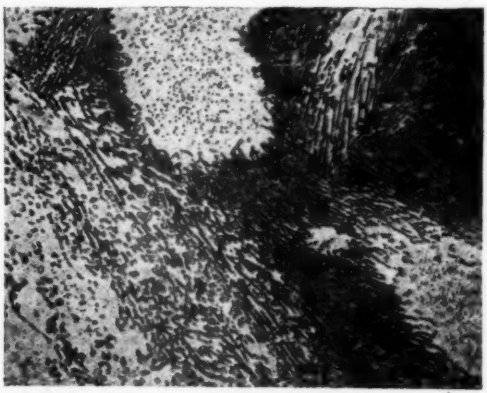


FIG. 10.—*Photomicrographs of typical structures of* (*a*) (*top, right*) *BS* 1400 *AB*1 *alloy*, × 100, *and* (*b*) (*bottom, left*) *and* (*c*) *BS* 1400 *B*2 *alloy at* × 100 *and* × 500 *respectively.*

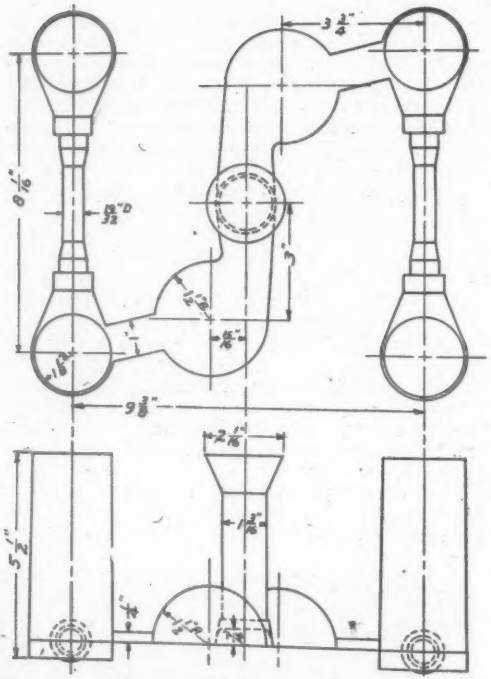
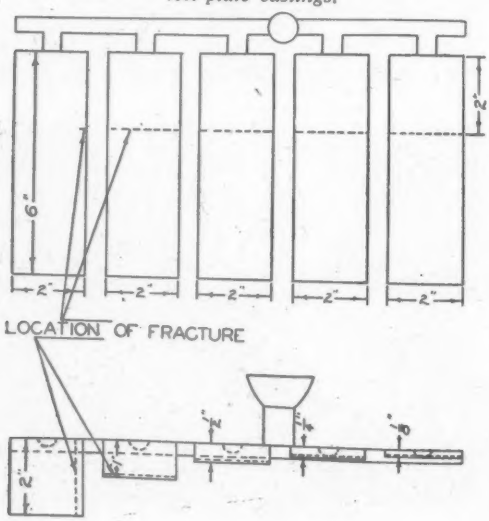


FIG. 11.—*LTB-2 tensile-bar design. The original version was modified by increasing the height of the open riser from 4 to 5 in.*

in the mould and even with reasonable care it is possible for there to be sufficient variation to give

FIG. 12.—*Mould layout for (American) fracture-test-plate castings.*



significant scatter of results. In the case of the triple bar, the bars almost invariably form at different rates and if the mould is cast level it is not uncommon for the metal to flow through one or two bars and back down the third towards the runner end: in the Eash-pattern bar, the rates of running of the four bars are most frequently very different. Numerous experiments had been made with the various known important factors under strict control, yet without reproducible results being consistently obtained, and it was finally decided that the evidence indicated that the manner of pouring each individual bar had been a critical factor not adequately controlled.

Controlled Pouring

Some experiments were made in pouring the IBF bars to make the pouring operation independent of the operator. They were poured through a separate downgate and with a choked ingate to the bottom of one feeder, Fig. 14(b). This ingate was of semi-circular section and about 2-in. long, first with $\frac{1}{4}$-in., then $\frac{9}{16}$-in., and finally $\frac{7}{16}$-in. dia. Typical results are shown in Table V. The pronounced influence of casting temperature on the properties of IBF bars but not on density is a typical feature: 1,160 deg. C. gives the best results with 86/7/5/2 gunmetal when run in the normal manner. When using a $\frac{1}{4}$-in. dia. choke, while the highest temperature gives results rather superior to those given when lower temperatures are used, again there is no significant difference in density. With the $\frac{7}{16}$-in. dia. choke, the same observation can be made, but while there is no marked change in density there is some advantage to be gained from the highest casting temperature (1,160 deg. C.) and consistency is improved. With the smallest choke ($\frac{7}{16}$ in. dia.) the mechanical properties are superior to all casting temperatures, and the consistency at each temperature is comparatively good: the densities happen to be rather higher than those of the other bars included in Table V, but even though these higher densities are not always maintained, the statement made holds true. The very slight superiority of bars cast at 1,080 deg. C. over those cast at 1,120 deg. C. is an interesting feature frequently observed.

Following upon this research, the modified running method was applied to production melts, and whilst the consistency using the $\frac{7}{16}$-in. dia., semi-circular choke has not been maintained as high as in the trials, it is far better than anything that has been achieved before. The effect of casting temperature has been reduced considerably, and it is clear that the level of the test-bar results is not a function of density alone.

Macrostructure

A study has been made of the macrostructures of test-bars. Test-bars giving good results have structures which are essentially columnar over the test portion, and the best bars not infrequently show a well-defined zone of unsoundness at the centre. Poor bars show an equiaxed grain structure with unsoundness distributed over the section. Fig. 17 shows the macrostructure of a normally-run IBF

bar (upper) compared with that of a bar of the same design poured through a separate downgate with a ⅞-in. dia. semi-circular choked ingate: the marked difference between the structures of the test portions of the bars would lead to an equally marked difference in the test results. Fig. 18 shows three broken bars from a triple bar: the structures of the centre and upper bars are identical, with pronounced columnar grains in the test portions, while the structure of the third bar is equiaxed—the change in grain size at the right-hand end is interesting and is probably to be associated with the way in which the bar was made. The test results given by these bars were:—

	U.T.S., Tons per sq. in.	Elongation, per cent.
Upper	16.5	26*
Centre	15.9	25*
Lower	10.0	9

* Broke outside gauge marks.

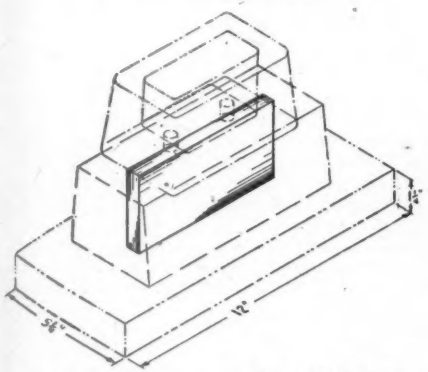


FIG. 13.—*Assembly of (American) chill-block core and chill plate, developed to adapt the fracture-test for practical application.*

It is considered that it is this feature of macrostructure which is significant where test-bar results are concerned. The columnar macrostructure is clearly dense, and even though there might be a considerable zone of unsoundness at the centre, reducing the overall density of the bar, satisfactory test results can be obtained. On the other hand, with an equiaxed structure, unsoundness is more uniformly distributed, resulting in poor test results. Macrosections prepared of bars sectioned along their entire lengths disclosed at the ends structures essentially columnar at the surface with equiaxed grains in the centre, and with a columnar structure through the test portion of a good bar. This equiaxed structure at the ends tends to taper off along the centre-line of the bar usually from the end remote from the runner, and if it extends considerably into the test portion it leads to a poor result and probably the bar breaking outside the gauge marks—Fig. 19, ingate end "I," riser end "R." It is probable that this is the principal variable which arises from bar to bar with bars cast from the same heat in the same box in succession, leading to inconsistency in test results.

Test-bar Design and Dimensions

The design of the test-bar as cast, particularly of the test portion, is obviously one of the critical factors in influencing the mode of solidification. The centre portion of the cast bar, or test sample, should be as close as is reasonable to the machined size of the test-piece and suitably blended with the bar ends. Some thought should be given to this factor when considering American test-bar results and American specification values, a matter of particular interest currently in some sections of the industry: for example, the LTB-2* bar used in the work

* Other standard American bars given in ASTM B.208 are cast ¾-in. dia. for finishing to 0.5 in. diameter. Gauge length in all cases is 2 in.

TABLE IV.—*Typical Results obtained with the Eash-pattern Bar (Casting Temperature 1,160 deg. C.)*

Secondary ingot.				Virgin metal.			
U.T.S., tons per sq. in.	Elongation, per cent.	U.T.S., tons per sq. in.	Elongation, per cent.	U.T.S., tons per sq. in.	Elongation, per cent.	U.T.S., tons per sq. in.	Elongation, per cent.
18.6	23	17.4	19	19.5	40	19.2	35
17.2	18	17.0	18	16.0	20	18.6	32
14.1	10	13.0	8	15.8	17	18.3	18
11.6	7	11.1	6	13.7	13	13.3	13

TABLE V.—*Typical Results obtained with IBF Bars, but using Various Types of Ingate (Bars not all Cast from the same Heat).*

Casting temperature, deg. C.	Normally run.			With semi-circular gate. ¾ in. diameter.			With semi-circular gate. ⅞ in. diameter.			With semi-circular gate. 1 in. diameter.		
	Density, gm. per c.c.	U.T.S., tons per sq. in.	Elongation, per cent.	Density, gm. per c.c.	U.T.S., tons per sq. in.	Elongation, per cent.	Density, gm. per c.c.	U.T.S., tons per sq. in.	Elongation, per cent.	Density, gm. per c.c.	U.T.S., tons per sq. in.	Elongation, per cent.
1160	8.72	19.1	40	8.69	17.6	28	8.59	17.7	23	8.84	20.1	44
	8.71	15.4	21	8.60	14.5	13†	8.62	15.0	17	8.85	19.9	40
	8.72	17.7	29	8.72	14.8	16†	8.63	16.8	23	8.83	18.1	20
1120	8.64	13.1	14	8.69	17.0	25	8.75	20.2	45	8.77	17.3	23
	8.66	10.1	8	8.67	18.0	30	8.74	15.0	12	8.77	17.4	23
	8.65	12.3	10	8.65	16.2	20	8.67	15.6	17	8.79	17.4	24
1080	8.76	14.2	11	8.72	16.3	19	8.77	16.6	17	8.81	18.7	29
	8.73	12.2	10	8.72	10.4	6†	8.73	16.6	10	8.80	17.2	21
	8.71	12.6	12	8.69	16.8	18	8.72	15.6	16	8.82	17.8	23

† Defective bars.

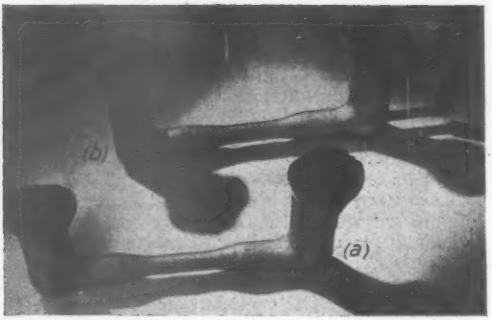


FIG. 14.—*(a) Modified version of the IBF test-bar (usually run through one of the open risers); (b) IBF test-bar with revised gating arrangement.*

described earlier is cast at $\frac{18}{32}$-in. dia. and machined to 0.5 in. dia., as compared with the original IBF bar designed to be cast at $\frac{1}{2}$-in. dia. for finishing to the standard 0.564-in. dia.—the modified form discussed which has been developed is cast $\frac{5}{8}$-in. dia. at the centre also for finishing to the standard size. Quite clearly it is necessary to produce a marked columnar structure in order to obtain the general soundness necessary to produce consistent mechanical properties which truly indicate the properties the alloy is capable of giving when cast under standardized conditions. Macrostructure can be independent of density and quite satisfactory mechanical test results can be obtained from metal of relatively low density, a finding which is consistent with results obtained by the American investigators working on the fracture test[6].

The work on test-bars has served to confirm that the actual casting operation is of primary importance. The way in which the metal enters the mould cavity is a critical factor in the production of the desired macrostructure. This consideration would apply to gunmetal castings generally, and concerns not only the ingate, which is the principal factor in the case of the simple test-bar, but also all parts of the mould in the case of a more complex casting. With disturbed entry, the early initial development of columnar grains is affected, and the formation of muclei by the time that quiet conditions obtain leads to pasty solidification, resulting in an equiaxed structure with porosity distributed throughout, which is considerably aggravated by dissolved gas. With quiet entry, not only can the actual casting temperature be allowed to vary over a wider range, but the influence of dissolved gas assumes less importance because of the desirable mode of solidification, from which follows that the gas is segregated to have a relatively harmless effect. It is therefore important to give proper consideration to the methods of running gunmetal castings, probably more than has sometimes been thought necessary in the past, and as far as possible to eliminate the variable effect of the human element in the actual pouring operation.

Summary and Conclusion

To summarize, reference has been made to the work of Baker and Pell-Walpole, who separately studied the effects of dissolved gases and methods for removing these gases. Baker and his colleagues of the BNFMRA also developed the technique of controlling the gas content of metal in the mould by metal/mould reaction to favourably influence the distribution of shrinkage porosity.

Gas content is derived from:—

(1) Gas introduced during melting.

(2) Gas introduced in transferring metal from the furnace to the mould.

(3) Gas introduced by metal/mould reaction, which is influenced by:—(a) Phosphorus content; and (b) condition of the mould: moisture content, permeability, hardness of ramming, and degree of drying (if it should be dry).

(4) The effect of impurities which can influence gas content.

The obtaining of satisfactory mechanical properties in gunmetal castings has been shown to be related to mode of solidification, and it has been demonstrated that control over the entry of the metal into the mould cavity is an important factor in this connection. The control over pouring has the effect of reducing sensitivity to casting temperature, and, with the ideal mode of solidification, the influence of dissolved gas is minimized. Taking these points into account along with the past experience of foundrymen and the indications of Cibula's work, there is little doubt that mode of solidification is a vital factor in the production of pressure-tight castings. Mode of solidification is influenced by:—

(1) Temperature of the metal in the ladle.

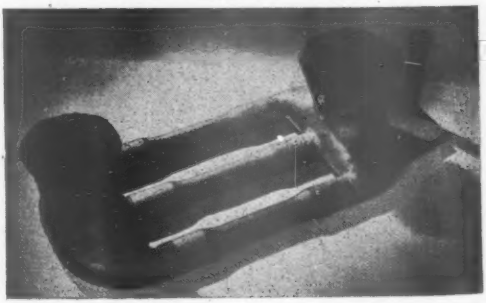
(2) Running method, which can influence the actual casting temperature in the various parts of the mould and the way in which the metal fills the various parts of the mould.

(3) The pouring of the mould, a factor usually under the control of an operator.

(4) Condition of the mould: moisture content, permeability, hardness of ramming, and degree of drying (if it should be dry).

(5) Composition: particularly with regard to the presence of impurities which can influence grain size.

FIG. 15.—*Version of the triple test-bar as recommended in BS* 1367.



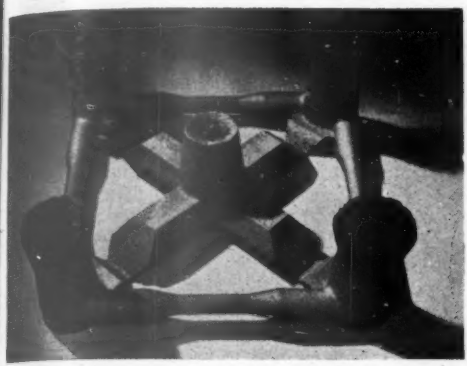


FIG. 16.—*Slightly modified Eash-pattern test-bar, better known among light-alloy founders.*

Gas Content

It might be that there are foundrymen who believe that they have the various factors set out under such control that the only significant variable in their practice is the gas content of the metal; if this be so, then it should be possible for them to bring this factor under control by such methods as the oxidation/reduction treatment, or nitrogen de-gassing, or both, if desired followed by metal/mould reaction. If they feel that, even so, it is necessary to check the metal for gas content, or to check the efficacy of their pre-casting treatment, it might be possible for a reliable melt-quality test to be devised for this purpose, and it is understood that Mr. Frank Hudson[15] and an IBF sub-committee[16] have been working separately on this problem. On the other hand, it has been shown that provided there is not an excessive amount of gas present, which experience indicates is usually the case, gas content is not a factor of primary importance, provided that the mode of solidification is under control. It is suggested that, far too frequently, when there are troubles with gunmetal castings attention is focused upon gas content of the metal (which, with the knowledge already available, should be under control) when, in point of fact, attention to the many variables which can influence mode of solidification would yield better results.

Of the critical factors mentioned, only metal composition and the dissolved gas present could be checked by a melt-quality test made before casting, if a suitable one could be devised. As far as is known, no-one in Britain has successfully operated the American fracture-test, which the investigators intended should reveal gas content and those factors influencing the mechanical-test results. It is indeed doubtful whether a melt-quality test for use before pouring will be devised to give help to the foundryman beyond indicating the gas content of the metal in the furnace or in the ladle.

With regard to melt-quality tests after pouring, the use of chemical analysis is limited, apart from its use for the determination of the main constituent elements, because of lack of a sufficient knowledge of the influence of impurities. This factor accentuates the importance of the test-bar.

Mode of Solidification

The work described concerning test-bars shows that the important factor in obtaining consistent results is mode of solidification, that macrostructure can to a large degree be independent of density, and that reasonably good mechanical properties can be obtained with metal of relatively low density. As only a test-bar technique which yields consistent results can be regarded as satisfactory—and in order to obtain consistent results, it is necessary to use a technique which controls the mode of solidification of the bars, and it is quite unreasonable to expect that test-bars would indicate melt-quality, taking into account the effects of the gas content of the metal—they can be expected to indicate only the effects of composition. The use of gunmetal test-bars for the determination of mechanical properties up to now has been tantamount to a test of a founder's ability to make test-bars satisfactorily as well as being a test of the metal: with a suitable technique developed, this most unsatisfactory state of affairs would come to an end and a melt-quality test of greater significance would result. A start has been made in this direction, but much work remains to be done.

Much valuable work has been done on the influence of gases in copper/tin alloys and attention is now drawn to the need for an investigation, of which the development of suitable techniques for making test-bars would form part, into the influence of important factors in foundry practice, particularly those which affect mode of solidification, on the quality of copper/tin alloy castings, and to the need for knowledge on the effects of impurities.

CONCLUSION

There are established melt-quality tests for use prior to casting for the high-tensile brasses and aluminium-bronzes. There is sufficient knowledge of the influence of impurities on these alloys for chemical analysis to be a useful means of checking the material after casting, and satisfactory test-bars can be cast, giving consistent results.

With regard to the copper/tin alloys, there is at present no suitable melt-quality test for use prior to casting, although work is in progress in this field: it is considered that the best that can be reasonably hoped for in this direction is a test to indicate the gas content of the metal in the ladle. There is insufficient knowledge on the effect of impurities for chemical analysis to serve a useful purpose beyond the determination of the essential elements. This accentuates the importance of test-bars, but as consistent results which truly indicate the properties of the metal have not normally been obtained, test-bars cannot be regarded by foundrymen as a satisfactory means of assessing melt quality. The point should be made that the corollary from this is that the foundryman stands to have castings rejected which are made from quite satisfactory material rather than *vice versa*. It also

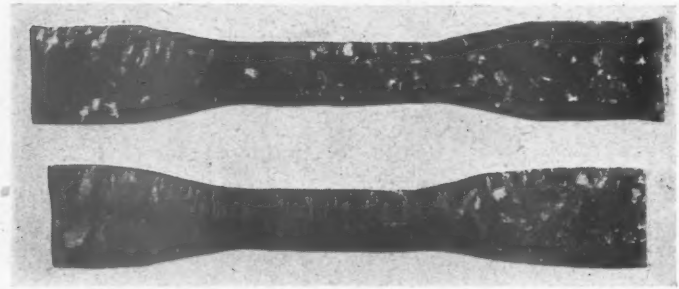


FIG. 17.—(*upper*) *Macrostructure of a normally-run IBF test-bar compared* (*lower*) *with that of a similar bar run through a separate downgate and semi-circular choked ingate.*

follows that with more knowledge on this subject it would probably be possible without altering the satisfactory quality of the metal normally supplied, that is without increase in cost, to raise the specification values to a more realistic level, which would be of the greatest assistance to the industry in competition with overseas suppliers.

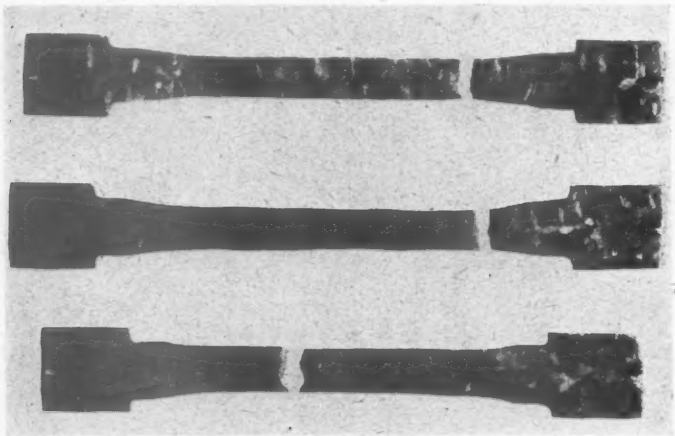


FIG. 18.—*Macrostructures of three broken test-bars from a triple-bar set.*

That there is no test of melt-quality to use after casting which can be regarded as satisfactory to the foundryman is an embarrassment which probably has more serious economic effect than he might at first imagine: directly, in the possible effect on the amount of scrap produced in the foundry and, more indirectly, in his relationship with his customers and suppliers. The industry has omitted to face the test-bar problem and to give it the serious attention which it has demanded. The problem has undoubtedly been recognized, probably from the time test-bars were first introduced, and in the past 20 years much time and endeavour has been put into what almost amount to individual efforts to find which design of test-bar would give the best results. It is hoped that the work described in this Paper has served to emphasize, first, that this is a complex problem involving primarily those factors which would influence the mode of solidification, as with this under control the effect of the gas content, within reasonable limits, is minimized: second, that this is a problem which demands a more fundamental approach and one which should be undertaken (sponsored by the industry) in one of the research institutions.

The immediate problem refers to a particular casting called a test-bar which is cast extensively in most foundries for finishing to a standard size and form, and the results of the work would therefore form a useful basis for further development towards improved techniques for making general castings.

Acknowledgments

The Author wishes to express his thanks to the directors of his company, J. Stone & Company (Charlton), Limited, and in particular to Mr. S. A. E. Wells, F.I.M., director and chief metallurgist, for permission to publish this Paper. He is also indebted to a number of his colleagues for their kind assistance with the text of the Paper, and in carrying out some of the work involved.

(*Continued on facing page at foot of col.* 1).

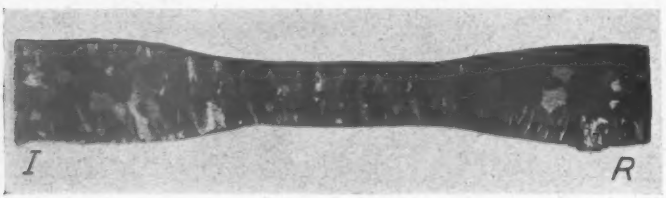


FIG. 19.—*Macrostructure of test-bar exhibiting equiaxed structure in the head* (*I denotes ingate end and R riser end*).

Iron and Steel Works Accidents

The unavoidable element of risk for those employed in the iron and steel industry is responsible for the growing attention being paid to accident prevention. This was reflected in a reduction in the accident frequency rate in the industry group concerned from 3.64 in 1949 to 2.61 in 1952. The rate is calculated by dividing the number of accidents in a given period by the total man-hours worked and multiplying by 100,000.

Experience in two steelworks may be quoted:—At one rolling mill employing some 1,000 workers, the time lost through accidents amounted in 1947 to 120,000 hrs.; by 1951, this loss had been cut to only 14,000 hrs. Again, in another large iron and steel works, the following striking reduction in accidents was secured, despite the distractions of a considerable expansion programme—in 1948, the number of lost-time accidents was 254 (a frequency rate of 3.19); corresponding figures for the next three years were:—1949, 222 (2.77); 1950, 209 (2.49); 1951, 184 (2.18). The total accidents reported for the metal producing group in 1948, 1950, 1952 and 1953 were as follow:—1948, 23,819; 1950, 21,668; 1952, 19,048; 1953, 18,185. The total number of accidents reported by these industries, according to the British Iron and Steel Federation, fell by 24 per cent. between 1948 and 1953, as against a fall of only 13 per cent. for all factory trades. The largest reduction was in accidents caused in iron and steel and other metal rolling, the figure falling from 11,221 in 1948 to 7,725 in 1953.

The work of the British Iron and Steel Federation in this field provides an example of the functions of a co-operative organization:—(i) The Federation is the medium through which information is made available to companies, *e.g.*, film strips illustrating the causes of accidents in works; (ii) research has been instituted into accident causation: (iii) machinery has been established for the central study and discussion of accident prevention.

Tempering Iron Carbon Alloys

Studies of microstructural changes on tempering iron-carbon alloys have been made in the USA by Lement, Averbach, and Cohen; the results, presented to the American Society for Metals in November, represent the continuation of a previous study of the microstructural changes that occur in high purity iron-carbon alloys during tempering. The changes were followed by means of both the electron and light microscopes in the tempering range of 370 deg. C. to Ac_1. A previous paper dealt with tempering in the range of room temperature to 370 deg. C. It was shown that the first stage of tempering in iron-carbon alloys containing above about 0.25 per cent. C consists of the formation of an ϵ-carbide network at sub-boundaries in martensite and is completed at between 175 and 205 deg. C. in a tempering time of about 1 hr.

This is followed by the initial part of the third stage of tempering, which starts at a tempering temperature of about 200 deg. C. and involves precipitation of cementite concurrently with solution of the ϵ-carbide. Complete solution of ϵ-carbide occurs at a tempering temperature of about 315 deg. C. or lower. Cementite forms initially as elongated films at martensite boundaries, and as both platelets and globules within the martensite. The boundary films coarsen and the amount of cementite formed within the martensitic plates increases as tempering is continued up to 370 deg. C.

Present Investigation

In the present investigation, the microstructural changes in four high purity iron-carbon alloys were investigated. The most pertinent feature of this study were the observations on the carbide morphology, on ferritic grain growth, on rates of softening, and on the completion of the third stage of tempering.

It was found that, on tempering iron-carbon alloys above about 370 deg. C., coarsening and extension of cementite films at grain boundaries of the ferritic matrix occurred at the expense of cementite particles which dissolved within the acicular grains inherited from the martensite. Cementite films formed at both prior martensitic and prior austenitic grain boundaries, but appeared to be more persistent at the latter locations on tempering at higher temperatures.

The process of displacement of cementite to grain boundaries was accompanied by spheroidization and coalescence of cementite both within the grains and at grain boundaries. All of these processes occurred more readily the lower the carbon content of the alloy. Although formation of cementite films might be a hardening factor during the tempering, it was apparently overbalanced by such softening effects as spheroidization, coalescence, and depletion of the carbon content of the matrix.

The enhanced solubility of carbon in the matrix reported to exist in plain carbon steels during tempering was attributed to the presence of small, coherent particles of cementite which might differ in composition from the formula Fe_3C.

Melt-quality Tests for Copper-base Alloys

(Continued from facing page)

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Institute Elects New Members

At the Council meeting held at Derby earlier this year, the following were admitted to membership of the Institute of British Foundrymen in the grades indicated:—

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NINE MEMBERS of the Electric Furnace Company, Limited, Weybridge (Surrey), who have been with the EFCO group of companies for 25 years or more, have received gold watches.

Coke Evaluation by Cupola Experiment*

By Prof. Dr.-Ing. H. Jungbluth

B. Osann developed for the blast furnace process a "Coke-evaluation factor," which can also be used for the cupola.

Taking as an example a coke with 83·2 per cent. C, 10 per cent. ash, 4 per cent. moisture, 2·4 per cent. volatile matter and 0·8 per cent. S, one requires for each 100 kg. coke used:

(*a*) for the conversion of ash into slag	11·0 kg. CaO
(*b*) for the conversion of sulphur into slag ..	2·8 kg. CaO
Total..	13·8 kg. CaO

Of limestone (containing 57 per cent. CaO and 43 per cent. CO_2) there will be required	7·9 kg. CaO and 5·9 kg. CO_2 respectively
Total..	13·8 kg.

The 7·9 kg. per cent. CaO will form with 10-kg. ash about 18 kg. of slag, requiring for its melting about 9,000 Kcal.

To remove the 5·9 kg. of CO_2, 5,658 Kcal. are required; for converting the moisture content of the coke (4 kg. H_2O) into steam an additional 2,544 Kcal. are necessary; a total, therefore, of 17,202 Kcal.

Application to the Cupola

This method of calculation for the blast furnace can be applied to the cupola by introducing the definition of the "ratio of combustion" (R_c), which is expressed by the formula

$$R_c = \frac{CO_2}{CO_2 + CO} \times 100 \quad \ldots\ldots \quad (A)$$

This formula gives the relationship between carbon-dioxide and the total products of carbon combustion in the flue gases. This ratio of combustion in the cupola is frequently about Rc = 50 per cent., that is to say: it appears as if 50 per cent. of the carbon content of the coke charge would burn to produce CO_2 and the other 50 per cent. would burn to CO, for instance, if in the end a flue gas with 13 per cent. CO_2 and 13 per cent. CO were obtained, then

R_c would be $\frac{13}{26} \times 100 = 50$ per cent.

The combustion of 1-kg. carbon produces 5,266 Kcal.; in order to obtain the 17,202 Kcal mentioned earlier, 3·27 kg. carbon is therefore required which is contained in 3·93 kg. coke of 83·2 per cent. C. (as per example).

Again, in order to have this 83·2 kg. of carbon actually available for melting, one requires in addition to the original 100-kg. of coke an extra of 3·93 kg. (for melting of slag; removal of CO_2 and conversion of moisture into steam), the total is therefore 103·93 kg. coke for 83·2 kg. C. In other words, 125 kg. of coke are required in order to have 100 kg. combustion carbon available. This figure 125 is Osann's "coke-evaluation factor," already a very useful figure for the expression of the reduction in coke value by existing contents of ash, moisture and sulphur.

Jungbluth and Heller developed a formula for the relationship between melting performance, coke charge, blast volume and ratio of combustion as follows:

$$M = \frac{60}{10} \times \frac{B}{\frac{C \times c}{100} \times 4{\cdot}45 \times \frac{100 + R_c}{100}} \quad \ldots\ldots \quad (B)$$

where, in this formula: M = melting performance in tons per hr.; B = blast volume in N cub. m. per min. (normal cubic metres per minute); C = coke charge per 100 kg. iron; c = carbon per cent. of the coke, and

R_c = rate of combustion $= \frac{CO_2}{CO_2 + CO} \times 100$ (see A)

If all the carbon were burnt to CO_2 and remained as such until leaving with the flue gases, the rate of combustion Rc would be 100 per cent. and the melting performance M (at constant blast volume) would be always exactly inversely proportional to the quantity of combustion carbon available per 100-kg. iron, expressed by $\frac{C \times c}{100}$.

However, part of the CO_2 will be reduced to CO according to the equation:

$CO_2 + C = 2\ CO + 38{,}220$ Kcal. per k.mol. (kilogram calories per molecular weight expressed in kilograms).

The ratio of combustion R_c will therefore have a value much smaller than 100 per cent. and consequently the denominator in formula (B) decreases, which causes the melting performance M (at constant blast volume) to increase.

Further Experiments

Further experiments indicated that, for the same grade of coke, the ratio of combustion Rc depends on the value of $\frac{C \times c}{100}$ as illustrated in Fig. 1.

With increasing carbon charge per 100 kg. iron $\frac{(C \times c)}{(100)}$, the quantity of iron passing the hot zone of coke becomes smaller, thus more heat can be given up to the iron and it becomes hotter.

* Abstracted by Dr. O. P. Einerl from a paper given to the annual general meeting of the *Verein Deutscher Giessereifachleute* at Stuttgart.

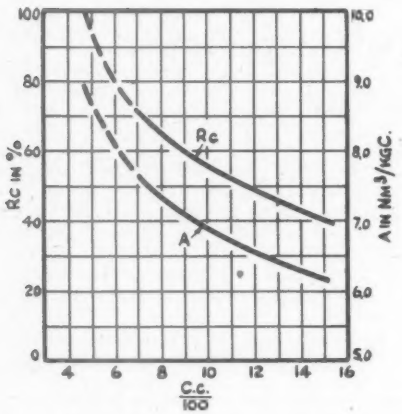


FIG. 1.—*Relationship between combustion carbon charge per* 100 *kg. iron* $\left(\frac{C \times c}{100}\right)$, *air volume per* 100 *kg. carbon* (*A*) *and ratio of combustion* (R_c).

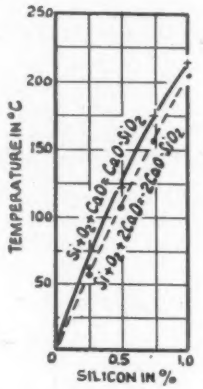


FIG. 2.—*Temperature increase by combustion of silicon.*

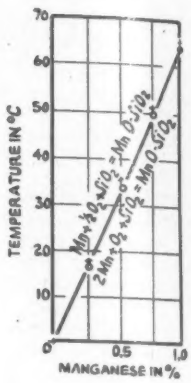


FIG. 3.—*Temperature increase by combustion of manganese.*

There are also other heat producing reactions which might confuse the picture, first of all, the oxidation of silicon, which is the basis of the Bessemer process. Fig. 2 illustrates the temperature increase of a *n* iron charge when 0·25 per cent., 0·5 per cent., 0·75 per cent. and 1 per cent. Si burn to SiO_2 and form a slag with the lime. Already, a melting loss of 0·25 per cent. Silicon raises the iron temperature by about 60 deg. C. which compensates a lack of combustion carbon in the coke charge. Fig. 3 illustrates the temperature increase by oxidation of manganese which is much less effective.

Summary

Expert coke evaluation by cupola experiment is only possible by taking note of scientific knowledge so far developed, if wrong conclusions are to be avoided. However, the theory of the cupola has already been sufficiently developed to provide a basis. It would be desirable to possess laboratory methods which would make large-scale cupola experiment unnecessary, but the industry is not yet so far advanced, though it should not be too difficult to achieve this in the future.

Steel Industry's Record

Steel production in February averaged 394,200 tons a week, which establishes a new output record. Last month's production compares with a weekly average of 380,600 tons in January, which was the previous best month, and with an average of 357,300 tons in February of last year.

The Iron and Steel Board announces that pig-iron production last month was also at a peak rate, the weekly average being 241,700 tons, which compares with the previous highest rate of 236,400 tons in January.

Latest steel and pig-iron output figures compare as follow with earlier returns:—

Period.	Pig-iron		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
	Tons.	Tons.	Tons.	Tons.
1955—January ..	236,400	12,292,000	380,600	19,789,000
February ..	241,700	12,567,000	394,200	20,498,000
1954—January ..	229,600	11,941,000	360,300	18,737,000
February ..	222,300	11,557,000	357,300	18,577,000

FOIRE DE PARIS—the Paris international trade fair—will be held in Exhibition Park, from May 14 to 30.

Huge Generator for East Midlands

What is believed to be the largest turbo-generator of its type in Europe has been ordered from the English Electric Company, Limited, by the British Electricity Authority. Rated at 200,000 kilowatts (260,000 h.p.), it will have twice the rating of the largest turbo-generator now in commission in this country. Only 24 of the 288 existing power stations in the UK have an individual output greater than the output of this single turbo-generator.

Subject to the Minister of Fuel and Power's consent to the establishment of the power station, the equipment will be erected at High Marnham on the River Trent. It will be the first of five turbo-generators of this size; when complete the station will be the largest in Great Britain, with a total installed capacity of 1,000,000 kilowatts, or over 1,300,000 h.p.

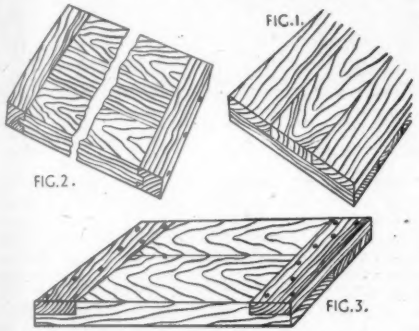
The BEA has also placed a contract worth nearly £10,000,000 with International Combustion, Limited, London, W.C.1, for three large water-tube boilers and ancillary equipment. It is believed that the equipment manufactured under this contract will be installed at the new station.

AT THE BEGINNING of April the sales division of the Aerograph Company, Limited, moves into new offices in the same premises as the DeVilbiss Aerograph Showrooms at 47, Holborn Viaduct, London, E.C.1.

Timber Strengthening

By "Checker"

When constructing some types of patterns or coreboxes, the patternmaker is on occasion faced with the problem of strengthening the timber in such a way that as far as possible the possibility of it shrinking, twisting, or warping is removed. With many patterns, especially those comprising mainly a thin, flat shape, stopping-off pieces can be screwed on to hold it straight and true. There are, however, occasions when this method is not to be preferred, and then the construction must be made so that ample timber strength is conferred.



FIGS. 1 TO 3.—*Simple methods of arranging cross-grain construction and strengthening of pattern timber.*

Fig. 1 shows the method of crossing the timber grain by using two layers of wood of equal thickness, which when fastened together give the desired dimension. As can be seen, the top boards are placed with their length across the widths of the bottom layer, and they are usually screwed or nailed together. In some instances, the timber may be constructed of three layers. Then the top and bottom layers are similar for position, with the boards running the full length, while those of the middle part are placed with their length across the width.

Instead of crossing the timber as mentioned, another way is to fix special end-pieces with their grain running the opposite way to the remainder of the work, to keep the timber straight. These are shown in Fig. 2, and their strength is produced in the tongue-and-groove which runs the full width. When using this method of construction, the tongue-and-groove ends are glued in place and screws may also be used for further security. The face and thickness of the timber is then planed to size after the glue has had time to set. This method gives a most satisfactory and lasting construction, being held perfectly straight and true. Besides using this method for actual pattern construction, it is also often used for making pattern boards.

Another way of holding timber straight and adding to its normal strength is shown in Fig. 3. This comprises let-in battens running the full width, and at each end. The recesses which are first cut out should have a depth of approximately half the total timber thickness. If they are too thin they may have insufficient strength to hold the body of timber firm and true against a tendency to twist.

Overcoming Shrinkage

The method which is shown in Fig. 4 illustrates how it is possible to overcome to a large degree the inward shrinkage of timber on the overall width. It illustrates two pieces of wood which are needed for producing a large pattern flange, which when finished required bosses on the outside shape. It also shows where the wood has been cut away in two places, and where the battens have been fixed in position across the grain. These battens should be approximately half the flange-depth, and extend in length to within a reasonable distance of the finished outside edges. They must be a good fit in the recesses which will receive them, especially so on the length dimension. When the larger pieces begin to shrink, the batten ends will give the resistance essential to prevent the outside width measurement varying, or such variation will be in very minor degree. Any shrinkage which takes place will be from the centre joint of the two boards, and these will open and show a corresponding space between them. The battens should be screwed

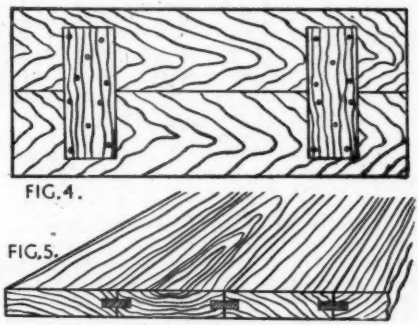


FIG. 4.—*Method of limiting the effects of shrinkage in pattern timber; and* FIG. 5, *a means of strengthening long lengths of board.*

into position, and it is most important with this type of construction, that none of the joints be glued.

There is an easy way to strengthen timber which is used in fairly long lengths and is only supported by other parts at the ends. This is by using a tongue-and-groove method as illustrated in Fig. 5. The grooves are quickly made by adjusting a circular- or dimension-saw to the desired height, and pushing the edges of the timber over. The tongue is made separately, to suit the groove provided when the boards are side by side. This way overcomes the inevitable springing to a great degree, when no other support is supplied by the pattern shape.

New Equipment

Mixing Machine

August's, Limited, of Halifax, have recently extended their range of sand-preparing machinery, by the introduction of the Mix-Muller which communicates a kneading action to its contents. The Mix-Muller consists of a circular stationary pan in which is mounted a combination of ploughs and mullers. The mullers revolve and the ploughs exert a shovelling action to the material that is being mixed, turning it over constantly on itself and directing it in front of the mullers. The mullers are adjustable and mounted on rocker arms so that they are free to float on the sand or other material being mixed, creating a rubbing action, but without causing actual grinding. Liquids can be added through a funnel mounted in the centre of the mixer. On completion of the mixing cycle, the material is discharged automatically by the action of the ploughs, through a door in the bottom of the pan.

In recent times, development in certain industries has created a demand for a new type of Mix-Muller, known as the "F" series, capable of giving greater milling pressure. This has been accomplished by using comparatively light mullers and a spring-loading device (Fig. 1), which allows a complete adjustment

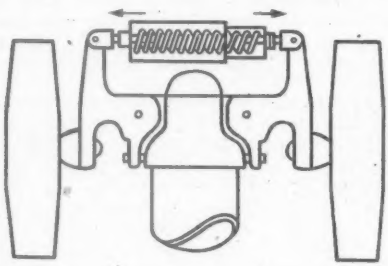


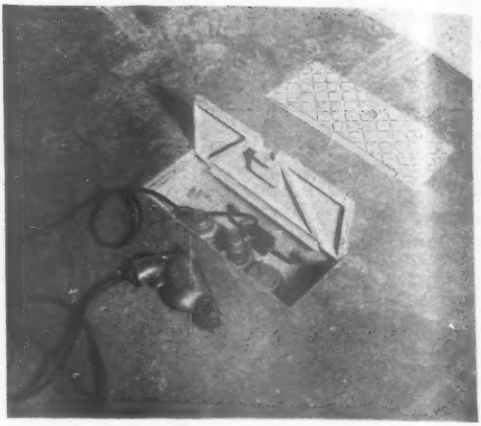
FIG. 1.—*Diagram showing the spring-loading device of the series "F," Mix-Muller.*

of variable muller pressures. One of the industries which is using these machines extensively is that devoted to the making of chemical plant. In some cases heating or cooling chambers are attached to the base of the pan.

It is suggested that this machine may give useful service in vitreous-enamelling departments. Again, for the laboratory, a quite small machine is made, carrying a pan of 24 in. dia. and actuated by a 1½-h.p. motor. It carries two mullers each 11 by 2½ in., weighing 100 lb. This is, of course, the smallest, but the standard range attains a capacity of 25 cub. ft. (No. 3).

Flexible Ducts

Spiratube, a lightweight ducting which is being produced by a new Scottish firm, Flexible Ducting, Limited, of Maryhill Glasgow, N.W., is being applied to the problem of coupling an air-intake or exhaust to a moving part of machinery. It is used for processes where it is necessary to attach a dust or grindings collection-system or a fume-extractor to the movable part of machinery. Spiratube consists of a pre-formed, pre-pitched, spring-wire helix, secured between overlapping plies of tough coverings, and is made in various types and sizes.



Floor Power-boxes

Recently in the columns of the JOURNAL the need for some means of eliminating trailing wires, pipes and the like in foundries, was commented upon. Now, the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, has issued a technical description of a box they have designed and marketed for this very purpose. It is illustrated above. The boxes described have been installed at the works of the Gloster Aircraft Company, Limited.

Bulk Delivery of Core Oil

The Fordath Engineering Company, Limited, Hamblet Works, Albion Road, West Bromwich, are giving an added service to foundries using their core oils. This takes the form of bulk delivery by means of a Leyland Comet 1,500-gallon tanker. As illustrated below, the tanker is divided into three compartments, so that different grades can be carried. Moreover, a meter and flexible hose is to be fitted, so that the smaller concerns can take modest quantities. The new system, which means a reduced price to founders using it, eliminates the handling and returning of empty drums and all the waste to be associated with repeated handlings.

Pig-iron and Steel Production

Statistical Summary of December Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past six months. Table II gives production of steel ingots and castings in December, and Table III, weekly average production of finished steel. Table IV gives the production of pig-iron and ferro-alloys in December, 1954, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	Price Index, 1938 = 100. I. & S.	Coal.	All comdts.	Iron-ore output.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy). Imports.[1]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[2]
1952[3] ..	254	329	323	206	190	228	202	171	29	310	252	683
1953	260	350	323	304	207	237	215	188	18	339	262	962
1954—July ..	265	365	328	284	213	227	221	142	4	263	216	1,078
August	265	365	325	266	238	237	227	177	5	326	229	1,128
Sept.[4]	265	365	324	293	231	232	223	212	7	372	293	1,063
Oct. ..	265	365	324	304	237	236	231	210	3	374	292	973
Nov. ..	266	372	326	302	241	241	235	211	6	377	303	900
Dec.[4]	267	372	331	301	236	240	234	196	7	355	—	831

TABLE II.—*Production of Steel Ingots and Castings during December*, 1954.

District.	Open-hearth. Acid.	Open-hearth. Basic.	Bessemer.	Electric.	All other.	Total. Ingots.	Total. Castings.	Total ingots and castings.
Derby, Leics. Notts, Northants and Essex ..	—	3.8	12.3 (basic)	1.8	0.2	17.2	0.9	18.1
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire	1.0	25.7	—	1.9	0.5	27.9	1.2	29.1
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	38.6	—	—	0.1	38.6	0.1	38.7
North-East Coast	1.9	68.3	—	1.1	0.4	70.0	1.7	71.7
Scotland	3.1	39.6	—	1.2	0.7	42.7	1.9	44.6
Staffs., Shrops., Worcs. and Warwick	—	17.4	—	1.1	0.7	17.5	1.7	19.2
S. Wales and Monmouthshire	4.4	68.1	6.2 (basic)	1.2	0.1	79.3	0.7	80.0
Sheffield (incl. small quantity in Manchester) ..	6.8	29.8	—	9.9	0.4	45.2	1.7	46.9
North-West Coast	—	1.1	4.7 (acid)	0.5	0.1	6.3	0.1	6.4
Total	17.2	292.4	23.2	18.7	3.2	344.7	10.0	354.7
November, 1954	20.6	309.1	23.6	20.3	3.4	365.8	11.2	377.0
December, 1953[4]	19.0	278.5	21.4	16.5	3.5	329.0	9.9	338.9

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product.	1952.[3]	1953.	1953. Nov.	1954. Oct.	1954. Nov.
Non-alloy Steel:					
Ingots, blooms, billets and slabs[5]	4.5	4.7	5.1	5.4	5.8
Heavy rails ..	8.0	8.7	9.8	9.4	10.0
Sleepers, etc. ..	1.8	2.2	2.9	2.3	1.6
Plates, 3 mm. thick and over ..	41.4	46.5	50.4	49.3	47.2
Other rolled prod.	39.0	43.9	49.1	49.8	47.7
Ferro-concrete rods, etc.	4.3	5.1	5.6	6.5	6.7
Wire rods and other rods[6]	15.9	15.6	18.2	22.9	23.4
Light rolled prod.	41.7	44.2	44.4	46.3	48.1
Bright steel bars	6.5	6.7	6.3	7.3	7.6
Hot-rolled strip ..	18.8	18.8	20.0	23.8	24.7
Cold-rolled strip ..	6.1	5.2	6.1	7.6	8.1
Sheets incl. coated	31.7	34.1	38.5	40.8	42.6
Tin, terneplate and blackplate ..	16.0	14.9	16.3	17.2	16.8
Steel tubes, pipes	20.1	20.1	22.2	19.6	23.5
Tube, pipe fitgs.	0.4	0.3	0.4	0.4	0.5
Tyres, wheels, axles	3.5	4.4	4.8	5.1	5.0
Forgings (excl. drop forgings) ..	2.8	3.1	3.2	2.7	2.5
Steel castings ..	4.2	4.0	4.3	4.0	3.9
Tool and magnet steel	0.3	0.3	0.3	0.3	0.3
Total	267.0	282.8	307.9	320.7	326.0
Alloy steel	13.4	13.7	14.1	14.2	15.0
Total deliveries from U.K. prod.[6] ..	280.4	296.5	322.0	334.9	341.0
Add: Imported finished steel ..	12.9	6.8	6.4	2.6	6.6
	293.3	303.3	328.4	337.5	347.6
Deduct: intra-industry conversion[7] ..	42.7	42.6	44.8	46.4	46.1
Total net deliveries of new material ..	250.6	260.7	283.6	291.1	301.5

TABLE IV.—*Production of Pig-iron and Ferro-alloys during December*, 1954.

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	26	2.0	18.4	23.2	1.0	—	44.6
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	6	—	13.7	—	—	1.0	14.7
Yorkshire (excl. N.E. Coast) and Sheffield)	—	—	—	—	—	—	—
Lincolnshire ..	9	—	34.2	—	—	—	34.2
North-East Coast	22	4.6	47.6	—	—	1.4	53.6
Scotland	9	0.5	15.4	2.2	—	—	18.1
Staffs., Shrops., Worcs., and Warwick ..	8	—	7.6	1.4	—	—	9.0
S. Wales and Monmouthshire	9	5.0	32.3	—	—	—	37.3
Sheffield ..	2	—	3.2	—	—	—	3.2
North-West Coast	8	17.2	—	0.2	—	1.5	18.9
Total ..	99	29.3	172.4	27.0	1.0	3.9	233.6
November, 1954..	96	27.2	176.9	27.0	0.8	3.4	235.3
December 1953[4] ..	107	27.5	163.8	29.6	0.4	4.1	225.4

[1] Weekly average of calendar month.

[2] Stocks mainly ingots and semi-finished at the end of the years and months shown.

[3] Average 53 weeks ended January 3, 1953, all tables.

[4] Five weeks, all tables.

[5] Other than for conversion into any other form of finished steel listed.

[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.

[7] Material for conversion into other products also listed in this table

Development at Thorncliffe

The directors of Newton, Chambers & Company, Limited, Thorncliffe, near Sheffield, have agreed to the expenditure of a substantial sum of money for engineering product development and for planning the re-equipment and reorganization called for by the development projects. In this connection, they announce the appointment of Mr. Edwin Watkinson as chief engineer, development, of the engineering division. Mr. Watkinson, who will be responsible to Mr. K. E. Walker, the assistant managing director concerned, has made a special study of the design and manufacture of the company's plant.

He joined Newton, Chambers as an apprentice in 1919 and, after general experience in the ironworks, he became leading draughtsman in 1936. He subsequently travelled extensively on the Continent and in 1939 was appointed manager of the company's fuel economy section. Mr. Watkinson, who took up the position of ironworks plant engineer in 1945, was responsible for the design of mechanized plant in the heavy foundry and supervised its installation.

Mr. Watkinson has served for some years on the committee of the Yorkshire branch of the Institution of Mechanical Engineers and the Institute of Fuel.

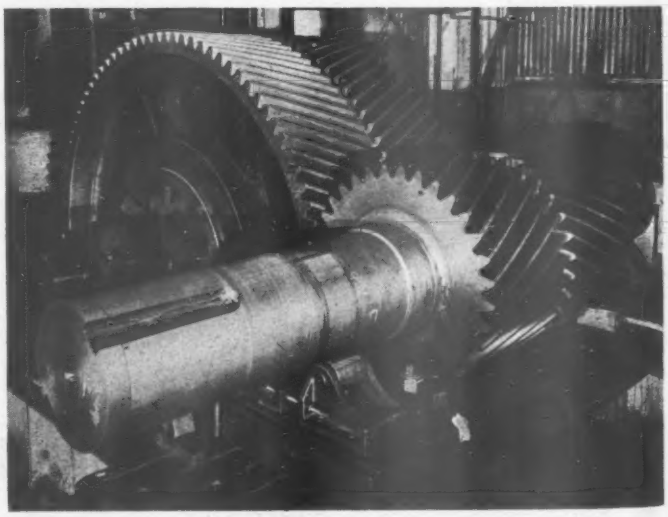
Belfast's Growing Trade and Facilities

Developments costing £1,000,000 are planned by Belfast Harbour Commissioners for the construction of additional berthage and sheds for foreign traffic, said the chairman, Sir Kenneth Sinclair, at the annual meeting.

In 1954 the port worked to capacity, said Sir Kenneth, reviewing the year. Income rose by £63,000 on 1953, with tonnage from foreign ports exceeding 1,000,000 for the first time in the harbour's history. Fuel was among the commodities making for the increase in imports and more machinery was exported. Among the improvements completed during the year was the 407-ft. long coal-discharging wharf built on the east side of the Herdman Channel to serve the new power station at West Twin.

Gears for Shotton

An order for a particularly large pair of gears for the Shotton (Chester) rolling mills of John Summers & Sons, Limited, was recently completed by David Brown-Jackson, Limited, of Salford Works, Manchester. The wheel and the mating forged pinion shown in the accompanying illustration will provide the reduction gearing between a 5,000-h.p. slab mill and the pinion stand of a 45-in. slabbing mill. The wheel, which weighed 37 tons as-cast, was the largest ever made at the Salford works and necessitated running the two open-hearth steel melting furnaces in parallel, and bringing both to the pouring stage at the same time in order to give identical carbon content. The picture shows the gear and pinion running on test at David Brown-Jackson, Limited, before despatch.



Rolls-Royce Incentives

Over 11,000 workers employed at Rolls-Royce factories in Scotland learned recently that they can earn awards of up to £500 by submitting suggestions which will benefit production of aero engines. The scheme has already been operated successively at the parent works at Derby and is now being extended to include all other plants. The biggest award yet paid to a worker for an idea is £175. An official at Hillingdon, Glasgow, said that the object of the scheme, which covers all hourly-paid workers in the firm's Aero Division, was to encourage employees to bring forward useful ideas which would benefit the company. A four-page booklet explaining the scheme has been issued to all the workers.

The scheme follows the introduction last year of an "elderly employees' scheme" which involved the setting up of a special department where men over 65 could continue to work away from the "hustle and bustle" of the workshops proper. This "armchair workshop" was provided because it was felt that the elderly workers were upset if they could not keep up the pace set in the main production shops.

Record Industrial Output

Industrial production in January was 4½ per cent. above that for January last year, and was the highest yet recorded for that month. The Central Statistical Office index of January output for all industries was 132-133, compared with 127 in January of last year.

Between April and October of last year the average weekly earnings of all manual workers rose by 3 per cent., or 5s. 3d. The figure for October was the highest ever recorded, earnings being two thirds higher than in April, 1947, although the weekly wage index showed a rise of only 45 per cent. in the same period. In October the average weekly earnings of manual workers in manufacturing industry were £8 10s. 10d., compared with £8 5s. 5d. in April. The average number of hours worked was 46.3, the same as before the war, compared with 46.1 in April.

Company News

PETER BROTHERHOOD, LIMITED, engineers and iron-founders, of Peterborough—Shareholders are informed that the CIC has consented to the one-for-one scrip issue. The proposal calls for the capitalization of £350,000 of reserves and the issue will be made to ordinary shareholders registered on March 15.

BRUCE PEEBLES & COMPANY, LIMITED—The board recommends a participating dividend on preference stock of 2½ per cent., making 10 per cent., and a dividend on £355,560 ordinary capital of 15 per cent., with a bonus of 10 per cent., to make 25 per cent. These equity rates repeat those of last year, when they were paid on £177,780.

R. & W. HAWTHORN, LESLIE & COMPANY, LIMITED—An interim dividend of 5 per cent., less tax, is being paid in respect of the year ending June 30, on the £1,343,531 ordinary capital as increased by a one-for-two scrip issue. For the previous year an interim of 6 per cent. on £895,687 capital was followed by a final of 11 per cent. on the present capital.

BROWN BROS., LIMITED, stockholders of ferrous and non-ferrous metals, etc., of London, E.C.2—A final dividend of 12½ per cent. (against 11½ per cent.) is recommended, making 15 per cent. (against 14 per cent.). The preliminary figures for 1954 show that the group net profit advanced from £230,000 to £309,103 after a substantially. increased taxation charge of £412,269, compared with £263,055.

GLOUCESTER RAILWAY CARRIAGE & WAGON COMPANY, LIMITED—In announcing an unchanged interim dividend of 5 per cent., less tax, on the £1,098,136 capital in respect of the year to May 31, the directors state that it should not be taken as an indication of the final dividend, as the company has to meet increasingly keen competition for all its products. A final payment of 6½ per cent. made 11½ for 1953-54.

THOMAS BOLTON & SONS, LIMITED, copper smelters and refiners, etc., of Widnes (Lancs)—Profits for 1954 have shrunk from £245,138 to £60,841, due to a "distortion" of tax provisions, and the distribution on the £500,000 ordinary is cut by 2½ per cent. to 10 per cent. Final dividend is repeated at 7½ per cent., but the 1953 2½ per cent. bonus is omitted, while the 2½ per cent. interim paid last October was unchanged.

JAMES H. LAMONT & COMPANY, LIMITED, engineers and brassfounders, of Edinburgh—The Treasury has consented to the company's proposal to capitalize £80,000 of general reserve. To preserve the position of the preference shareholders it is intended to make not only an issue to ordinary holders of one share for every one of 2s. held (requiring £60,000), but also an allotment to preference holders of one new 6 per cent. cumulative 10s. preference share for every three preference shares in issue at the time of cancellation of existing participating rights. The issue would call for £20,000.

ASSOCIATED ELECTRICAL INDUSTRIES, LIMITED—As forecast, the board recommends a final dividend of 10 per cent., making 14 per cent. for the year 1954. The dividend is in respect of the £17,741,192 ordinary stock in issue prior to the further issue made in 1955 in exchange for ordinary stock of Siemens Bros. & Company, Limited. The total amount of the net ordinary dividend will be £1,366,073 as compared with £1,097,736 required for the year 1953 when the equivalent to 11½ per cent. was paid on the present capital. The consolidated untaxed trading profit of £11,736,000 compares with £10,745,000 in the previous year.

Midland Manufacturers' Meeting

Speaking in Birmingham on March 3 at the annual luncheon of the National Union of Manufacturers, Midland branch, Mr. Selwyn Lloyd, Minister of Supply, said that industry's duty was to continue the never ending search for better quality goods, lower costs and greater efficiency, and to produce cheaper and better products from the same number of men and machines. "It needs to be remembered that no one owes this country a living and it would be easy to price ourselves out of export markets" he said. "It must be brought home that every increase in wages that is not associated with increased productivity not only increases the cost of living but also increases difficulties in overseas markets."

Nickel and Aluminium Shortage

Of nickel, Mr. Lloyd said that supplies from the main source, Canada, were limited and the shortage would continue until the United States stockpiling programme was complete. Some supplies were available from Japan but would be more expensive. The shortage, however, although serious, was of comparatively small proportions.

Of aluminium, the Minister said that the shortage last year totalled 50,000 tons but this year it was not expected to amount to more than 30,000 tons. Discussing employment, Mr. Lloyd said that there are only two means of seeking to meet the shortage of labour —to train more skilled men and to introduce more and better machines.

On supply matters generally Mr. Lloyd said it was best to avoid costly, complicated and irritating procedures of rationing and allocation and the whole efforts of his Ministry would be directed to that end. With reference to the Midlands in particular, the Minister said that the great prospects of the motor industry, the application of atomic energy to power production, and the re-equipment of the railways would provide plenty of work for the region. At the same time, the exports challenge remained; international trade was still increasing and though last year Britain did not succeed in obtaining its due proportion of that increase, the nation's exports nevertheless reached a good level.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade, Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone CHAncery 4411, ext. 738 or 771), unless otherwise stated.

IRAQ, April 5—Cast-iron pipes, special castings, sluice valves, and surface boxes, for the Director General of Municipalities, Bagdad. (ESB/4899/55.)

STIRLING, March 25—Cast-iron frames and gratings for the year from May 16, 1955, to May 15, 1956, for the County Council. Mr. James D. Kennedy, county clerk, County Offices, Viewforth, Stirling.

AUSTRALIA, June 6—Regulating gates or valves and control equipment and accessories, for the Supply Officer, Snowy Mountains Hydro-Electric Authority, Sydney. (ESB/4782/55.)

AUSTRALIA, June 6—Jet flow gates and ring follower gates with hydraulic and electric controls, for the Snowy Mountains Hydro-Electric Authority, Sydney. (ESB/4740/55.)

AUSTRALIA, June 14—Radial gates, gate anchorages, and wall and sill plates, for the Snowy Mountains Hydro-Electric Authority, Sydney. (ESB/4902/55.)

HONITON (DEVON), March 24—Cast-iron surface boxes, stopcocks, ferrules, and gunmetal saddles, copper tubing, gunmetal tube fittings, malleable-iron fittings, spun-iron pipes and cast-iron specials, sluice valves, air valves, hydrants, etc., for the 12 months commencing April 1, for the East Devon Water Board. The Engineer, East Devon Water Board, 46, New Street, Honiton.

Personal

Mr. H. G. ISSELS, B.Sc., of Bulawayo, has been appointed to the Rhodesian Iron & Steel Commission.

Air Vice-Marshal ARTHUR FRANCIS HUTTON has been appointed director-general of engineering at the Air Ministry.

Mr. E. H. PAGE, secretary of Chamberlin & Hill, Limited, of Chuckery Foundry, Walsall, has been elected to the board.

Mr. J. W. TIDSWELL, assistant to an executive director of the Dunlop Rubber Company, Limited, has been appointed works manager of the company's factory at Hirwaun (Glam).

Mr. D. R. DAVIES, chief metalclad-switchgear designer of the switchgear engineering department, has been appointed consulting designer of Metropolitan-Vickers Electrical Company, Limited.

Prof. L. J. KASTNER, Professor of Engineering and head of the engineering department at the University College of Swansea, has been appointed to the London University Chair of Mechanical Engineering, tenable at King's College.

Mr. E. S. WADDINGTON, of the industrial division of Philips Electrical, Limited, has been elected chairman of the finance committee of the Society of Engineers. Mr. Waddington is hon. treasurer of the Society, which is the third oldest professional engineering society in the country.

RICHARD THOMAS AND BALDWINS, LIMITED, announce the appointment of Dr. JAMES WELCH as their director of education. Dr. Welch was director of religious broadcasting from 1939 to 1946 and until recently he was Professor and vice-principal at the University College, Ibadan, Nigeria.

Mr. W. V. STEVENS, secretary of the Edinburgh Chamber of Commerce, has completed his two-year term of office as president of the Association of Secretaries of Chambers of Commerce. He has handed over the presidency to Mr. RONALD WALKER, secretary of the Bolton Chamber of Commerce.

Sir WILLIAM SCOTT FARREN, who is technical director of A. V. Roe & Company, Limited, Manchester, has accepted an invitation to join the Air Safety Board in place of Air Commodore F. R. Banks, who recently resigned. Sir William was director of the Royal Aircraft Establishment, Farnborough, from 1941 to 1946.

BRITISH INSULATED CALLENDER'S CABLES, LIMITED, announce the appointment of Mr. R. H. STEEDS as regional manager (Scotland). He will work from the Glasgow Office. He joined BICC in 1945 as sales engineer, traction department, and in 1952 was made assistant sales manager, a position which he held until his present appointment.

Mr. A. E. COOK, who retired from the managing directorship of Cravens, Limited, rolling-stock manufacturers, of Darnall, Sheffield, in 1951, has relinquished his seat on the board. He has served the company for 44 years, as engineer, works manager, general manager, and managing director. The occasion was marked by a presentation from his fellow directors.

Sir HAROLD ROXBEE COX, chairman of the civil aircraft research committee of the Aeronautical Research Council, has been appointed an independent member of the Council of the Air Registration Board. Sir Harold resigned as chief scientist of the Ministry of Fuel and Power last August and joined the board of the Brush Group, Limited, the next month. He is also a director of Wilmot-Breeden, Limited, motor-car component makers, of Birmingham.

Mr. F. BATEMAN and Mr. R. F. MARSHALL have been appointed assistant managers of the education department of Metropolitan-Vickers Electrical Company, Limited. The former is now responsible for trade apprentice recruitment and training and the latter for professional apprentice recruitment and training and military service matters. In 1951 Mr. Bateman was placed in charge of the new apprentice training school, and Mr. Marshall was appointed section leader, professional engineering training.

AMERICAN CAST IRON PIPE COMPANY, of Birmingham, Ala., USA., announces that MR. STEPHEN D. MOXLEY, former executive vice-president, has been appointed president to succeed MR. CHARLES OTTO HODGES who retires after 38 years of continuous service. Mr. Moxley is widely known for his numerous inventions such as the cupola charger and flask handling device, as well as for his many articles in engineering and industrial management journals. He is a former national vice-president of the American Society of Mechanical Engineers and is a member of the Newcomen Society of England and American Foundrymen's Society.

Obituary

Sir JOHN BOWEN, who was for many years engineer-in-chief of the Corporation of Trinity House, died on March 4, at the age of 68.

THE DEATH OCCURRED on March 3 of Mr. WILLIAM ERNEST EGLIN, of Halifax, at the age of 74. Mr. Eglin was son of the founder of W. P. Eglin, Limited, brass founders and bedstead and tubular furniture manufacturers, Sowerby Bridge, near Halifax.

THE DEATH occurred, on March 8, of Mr. JOHN R. COURT, of Keighley, at the age of 81. Prior to his retirement in 1953, Mr. Court had worked for 57 years for Prince-Smith & Stells, Limited, during which time he travelled extensively on the Continent as a sales representative, after starting as an apprentice and becoming later a fitter and erector.

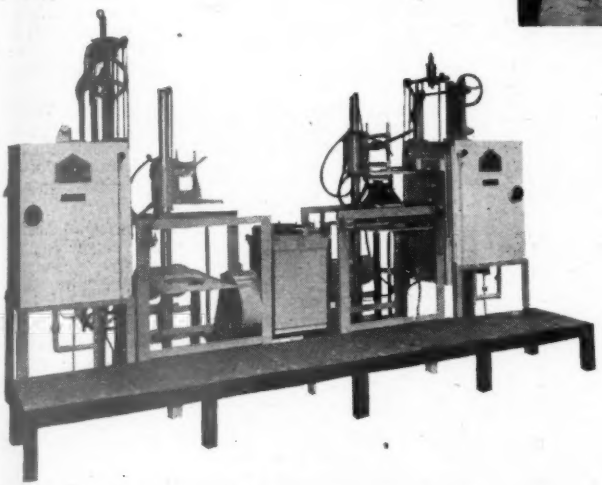
Mr. STANLEY DAVIES, general manager of the Redbourn iron and steel works, Scunthorpe, of Richard Thomas & Baldwins, Limited, until his retirement at the end of 1953, died on March 8, at the age of 67. He was a former chairman of the Lincolnshire Ironmasters' Association and a past-president of the Lincolnshire Iron and Steel Institute.

Mr. LLEWELLYN DANN, who died on February 28 at the age of 56, joined the Rubery Owen organization in 1940 as works manager of the electrodes factory. He was secretary of the subsidiary, Invicta Electrodes, Limited, Willenhall (Staffs), of which he was elected a director earlier this year. Previously he was associated with the Quasi-Arc Company, Limited, for whom he established a business in Australia at Melbourne.

THE DEATH has occurred of Mr. EDWARD DUGDALE SPENCER, who for 30 years was chief engineer to Taylor Tunnicliff (Electrical Industries), Limited, Eastwood, Hanley, Stoke-on-Trent. After studying engineering at Manchester University he gained practical experience with Mather & Platt, Limited, before joining the staff of a consulting engineer. On his return to this country after the first world war, during which he was interned in Germany, Mr. Spencer occupied a post in the plant engineering section of the Metropolitan-Vickers Electrical Company, Limited. Two years later he joined Globe Tank & Foundry (Wolverhampton), Limited, before commencing his long career with Taylor Tunnicliff in 1924. Mr. Spencer, who was 72, retired last year.

Shell Moulding in 3D

The Shelmolda 'Altus' will handle patterns up to 13in. in height or depth and therefore will provide a greater variety of sand/resin moulds than any other machine on the British market. All the main operations are carried out mechanically and the minimum of physical effort is required from the operator.



The Shelmolda "Altus" (patent applied for)

Capacity

Effective pattern plate sizes of 16in. by 16in. and 16in. by 12in Handles pattern plates 13in. high or 13in. deep in each oven. Will produce from split pattern 26in. overall. Oven opening adjustable up to 16in. above or below centre line.

Operation

Semi-automatic, with everything at all times under operator's full control. Oven doors, dump box and receptor pneumatically operated. Adjustable ejector mechanism. Investment time electronically controlled. Gas or electric ovens.

May we send you further particulars?

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AP 236-72

Film Reviews

Argonaut Welding Process:—16 mm.; sound and colour; running time 26 min. Available to schools, technical colleges and technical societies on application to the British Oxygen Company, Limited.

The BOC Argonaut welding process is explained by comparing the basic technical differences between this, the latest of the argon welding processes, and the Argonarc technique. The manner in which a thin consumable electrode is used in conjunction with a high-density arc to give continuous, all-position welding is shown by high-speed photography which slows the action on the screen by 125 times. In this sequence, the characteristics of the arc and droplet metal transfer can be clearly seen and is most interesting. Slow motion also gives a dramatic comparison of the use of argon and nitrogen as shielding gases. Brief examples of the process in use on aluminium, stainless steel, copper and mild steel are given. The last part of the film gives an impressive indication of the sections of metal on which the process can be used to advantage. For welding mild steel, Argonaut is 40 per cent. faster than the previous best.

Fuel Oil. Produced for Esso Petroleum Company, Limited, 36, Queen Anne's Gate, London, S.W.1; 16-mm. copies available free on loan on application to the Industrial Sales Department; (running time 25 min.).

This film was given its première in London last month to representatives of the Press at the Royal Empire Society's theatre. While, naturally, there was no disguise of the film's main purpose—extending the use of fuel oil—it was rather difficult to gather whether it is intended for technical or lay audiences. For the layman, there were excellent pictorial interpretations of calorific value; heating capacity *vis-à-vis* other fuel, and viscosity. However, to the reviewer there was insufficient attention given to industrial application and the interpretation of the technical data in terms of cost. A crucible melting furnace using oil was shown, but it would have been to advantage had this part been linked to advantages and (possibly) disadvantages. The photography was excellent and the dialogue impeccable.

New Catalogues

Centrifugal Fans. A leaflet received from Bellanger Bros. (London) Limited, illustrates, describes and prices a line of extractor-blower type centrifugal fan units.

Dust-control Units. A leaflet (No. 38) issued by Dallow Lambert and Company Limited, Spalding Street, Leicester, carries on one side an illustated description of their automatic shaker, type EA1, and on the reverse side a series of pictures showing installations of the shaker, including many suitable for application in foundries. It is available to readers on writing to Leicester.

Fire Door. A very interesting folder has been received from Maclelland and Company Limited (a company of the Flavel Group), 97 to 99, Praed Street, London, W.2. It deals with a furnace door, which is so designed as to permit extra air to enter a furnace at the time when, just after charging additional fuel, there is insufficient entry to burn the rapid distillation of combustible gas. It is interesting to note that the Newcastle United Football Club ground was plagued for weeks by black smoke, and that the nuisance, which emanated from a boiler in a nearby factory, has been eradicated by the installation of this door, known as "Smokelim."

News in Brief

Dr. CLYDE WILLIAMS, director of the Battelle Institute, recently opened a branch laboratory at Geneva.

THE ROYAL SANITARY INSTITUTE'S annual Health Congress will be held at Bournemouth from April 26 to 29.

GEO. SALTER & COMPANY, LIMITED, will move shortly into a new plant in Spring Road, off Spon Lane, Smethwick.

Mr. WALTER JACKSON, melting shop manager at the Appleby-Frodingham works at Scunthorpe, has been awarded the National Iron and Steel Institute's Williams prize for 1954. He also received £100.

THE MAYOR OF DERBY (Councillor Alec Ling) made a tour of the works of Aiton & Company, Limited, pipe engineers, of Stores Road, Derby. The Mayor was accompanied by Wing Commander J. M. Aiton (chairman and managing director) and Mr. E. G. Boissier (deputy chairman of the company).

THE STEELWORK for the towers for the floodlighting on Sheffield Wednesday football ground, said to be the most expensive installation in the country, and used for the first time for the recent match to benefit Derek Dooley, was fabricated and erected by Thos. W. Ward, Limited, Albion Works, Sheffield.

THE LOCH LOMOND STEAMER Prince Edward has been sold for scrap. The 44-year-old vessel will shortly be stripped of its interior furnishings and will probably be broken up alongside Balloch Pier where her predecessors the Prince George and Princess May were demolished some years ago.

NEWTON, CHAMBERS AND COMPANY, LIMITED, Thorncliffe Works, Sheffield, state in a message to their workpeople, "If full employment is to be maintained for our 4,000 employees we must book a minimum of £7 worth of orders per head per day for every man and woman, boy and girl in our employ."

SIR W. G. ARMSTRONG WHITWORTH, LIMITED, Coventry, is this year to experiment with staggered holidays for employees. Holidays will be taken by workers in different weeks during June, July and August. Details will be worked out between management, a joint production committee and shop stewards.

THE INDUSTRIAL WELFARE SOCIETY and the Sheffield branch of the Institute of Personnel Management has arranged a meeting for March 24. A talk will be given by Mr. John Gratwick on human implications of work-study, and films will be shown to indicate the reaction of managers and trade union men to the introduction of new methods in a factory.

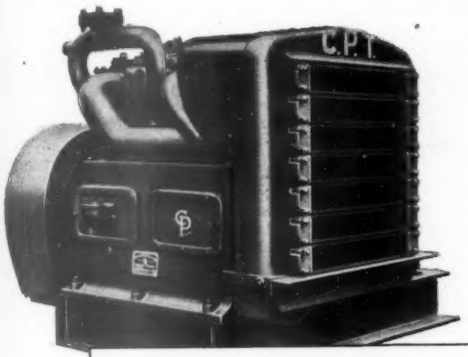
Mr. SYDNEY BARTON, of Bawtry, Yorks, has bought at an auction sale at Doncaster the Don Foundry, Town End, Bentley, together with the shop premises in Market Place, previously occupied by Mr. Alfred Hoyle, agricultural engineer. The price paid was £6,500, plus stock and fixtures, etc., at a valuation. Mr. Barton is one of Doncaster's honorary freemen.

THE AMATEUR OPERATIC SOCIETY of Firth, Brown and Firth Vickers held a social evening in the works canteen in Savile Street, Brightside, on March 5 attended by 250 members and friends. The society was visited during rehearsal by a BBC recording unit and extracts from the show, "The Quaker Girl," which is being given in April, may be broadcast.

AERO RESEARCH, LIMITED, northern area office has now moved to larger premises at 409, Royal Exchange, Manchester 2. (Telephone: Blackfriars 9445-6). Technical service and sales of "Aerolite," "Araldite,"

(*Continued on page 306*)

SIMPLE TO INSTALL!



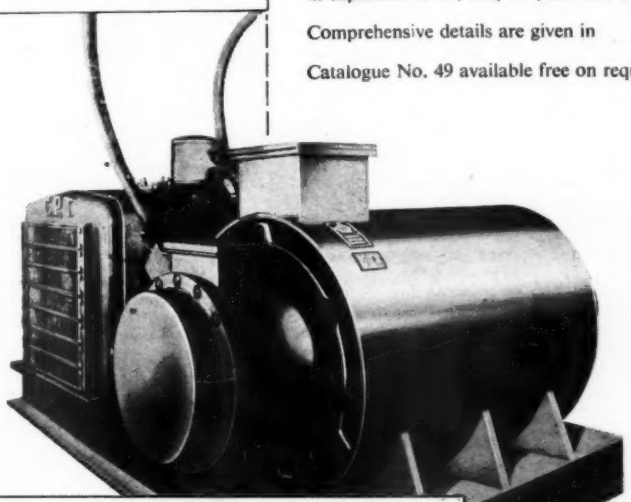
Compactness in design, and air cooling, simplify installation of these Class PB Stationary Compressors.

Wherever a reliable source of air power has to be installed and space is limited, this CP range of two-stage, air-cooled compressors deserves careful consideration.

See how neat they are in design, how compact when built-up on a sub-base, whether belt driven or direct coupled. This means real simplicity in installation.

For compressors that must give more or less continuous service without respite, these reliable units offer an outstanding choice, in capacities of 66, 125, 210, 315 and 500 cu. ft.

Comprehensive details are given in Catalogue No. 49 available free on request.



Consolidated Pneumatic

MAKERS OF HIGH-CLASS ROCK DRILLS, AIR COMPRESSORS AND POWER TOOLS

THE CONSOLIDATED PNEUMATIC TOOL COMPANY LIMITED, 232, DAWES ROAD, LONDON, S.W.6

News in Brief

(*Continued from page 304*)

"Resolite" and other of the company's synthetic resin products continue to be under the management of Mr. S. Hopwood, M.B.E., in the northern area.

AN ANALYSIS of "lost time" accidents in the Rotherham steelworks of the Steel, Peech & Tozer branch of the United Steel Companies, Limited, in 1954, shows that only seven out of 241 accidents involved machinery. Of the total number of accidents, 54 were the result of falls, 66 of falling material, and 50 of stepping on or striking against objects, while hand tools caused 12, and 58 were sustained during materials handling.

NOTHING could be worse than for a number of smokeless zones to be instituted and to fail because the right appliances and fuel were not available in sufficient quantities, Dr. G. E. Foxwell, past-president of the Institute of Fuel and a member of the Beaver Committee of Air Pollution, told the North Thames Gas Consultative Council. He was disturbed by the number of smokeless zones that were being instituted in advance of the official arrangements, he said.

THREE BUS OPERATING CONCERNS have ordered 54 chassis, worth more than £100,000, from Guy Motors, Limited, of Wolverhampton. All are repeat orders, and all are for Arab double-deckers, powered by Gardner 6LW Diesel-engines. The largest individual order is for 36, for Southdown Motor Services, Limited, Brighton. Ten more will go to Lancashire United Transport, Limited, of Atherton, Lancs., and eight to Middlesbrough Corporation Transport Department.

"FROM EARLY DAYS TO SERAPHIM" is the title of an exhibition now being held at Scunthorpe Museum, until the end of March, depicting the growth of the steel industry of North Lincolnshire. It shows in pictorial form the development of Britain's largest combined iron and steel plant, the Appleby-Frodingham branch of the United Steel Companies, Limited. There are shown the blast furnaces, melting shops, rolling mills and structural departments and also the ironstone mines in the north of the county.

A NEW British shipping company—the Avenue Shipping Company, Limited, formed last year by the New Zealand Shipping Company, Limited, in conjunction with Birt, Potter & Hughes, Limited—has just given its first shipbuilding order worth over £1,000,000 to Alexander Stephen & Sons, Limited, Glasgow. It is for a 9,000-ton cargo motorship. Propelling machinery will be of the Doxford type, and will give a service speed of 14 knots. Since the year began orders have been placed on the Clyde for seven ships, only one was received last year.

AT BRADFORD COUNTY COURT recently, Judge Myles Archibald dismissed an appeal for £200 damages made by a 61-year-old man in his claim against his employers, Frank Wigglesworth & Company, Limited. The man alleged that he tripped over a nail in the floor while carrying a pint pot of tea, and broke his wrist. Dismissing the claim with costs, the Judge said that the most satisfactory thing was the fact that the employee had entirely recovered. The accident was undoubtedly painful and was unpleasant for him, but it was no more than that.

THE SHEFFIELD AREA industrial group of the Royal Society for the Prevention of Accidents held their annual meeting on March 8. Officers elected were:—chairman, Mr. L. S. George (of the Park Gate Iron and Steel Company, Limited, Rotherham); vice-chairman, Mr. R. Rawding (Stanley Works, Limited); secretary, Mr. G. W. Staniland (Samuel Osborn & Company, Limited); treasurer, Mr. I. Gomer (Daniel Doncaster & Sons, Limited). Members elected to the executive committee were: Mr. A. Elson, Mr. L. Williams, Mr. G. May, Mr. R. Utey, and Mr. R. J. Tierney.

AT THE ANNUAL DINNER in Wolverhampton, on March 4, of the Wolverhampton and District Engineering Society, Mr. J. C. Mills, president of the Society, attacked what he called the "tyranny" practised by nationalized industries and services. "We are a people who hate tyrants" he said, "yet we have in the offices of the various nationalized industries men who have the power of tyrants. They tell us what to do and when to do it." Mr. A. G. B. Owen, managing director of the Rubery Owen group, expressed disappointment that young engineers in training did not take full advantage of the educational facilities freely at their disposal. He contrasted the attitude of the trainee engineer of previous times with that of the trainee to-day. For the first time in the 51 years of the Society's history, the dinner was attended by wives of members.

DORMAN, LONG & COMPANY, LIMITED, iron and steel manufacturers, Middlesbrough, has overseas bridge contracts in hand for over £3 million. These include projects in Iraq, Nigeria, Gold Coast and New Zealand. All the company's plant has been fully occupied in the 52 weeks reported on. Iron production rose by 94,273 tons to 1,300,371 tons. Ingot steel output was higher by 120,006 tons at 1,879,085 tons, while rolled steel, at 1,442,437 tons, was 28,170 tons lower but represented an almost identical weekly output. The company contributes approximately one-tenth of the manufacture of ingots in the United Kingdom. On the Lackenby site, work is proceeding on the building for the combined universal beam and heavy section mill, while at the Cleveland works construction of new blast furnaces, coke ovens and rolling mills is well advanced.

CONCERN AT THE LACK of suitable alternative sites in Coventry for industry displaced by redevelopment in the city, was expressed on March 8 at a meeting of Coventry area members of the National Union of Manufacturers. The meeting urged early action at national level to secure an improvement in the situation. Mr. E. Holden, Midland area secretary of the union, told the meeting that Coventry's redevelopment plan had had the effect of sterilizing land and property with a consequential hindrance on industrial expansion. He found that in preparing development plans local authorities gave the least thought to industry. The meeting also expressed concern at the trend towards increasing litigation by employees against employers with a consequent rise in insurance premiums covering accidents in industry. It was decided to support action aimed at securing early Parliamentary consideration of the situation.

AS A RESULT of the recent visits by 24 British businessmen to Peking, over 400 Standard Vanguard cars are to be sent to China. The mission which visited China concluded contracts valued at some £4,000,000 about equally divided between exports and imports. The Chinese were not prepared to place any orders for goods on the embargo list but it is understood that they went so far as to give letters of intent to a Midland firm for special steels which might soon be freed from the embargo. The visit is said to have confirmed an earlier estimate that Sino/British trade could reach an annual figure of between £80,000,000 and £100,000,000 (some 10 times the current level) especially as the Chinese have so much to export. The mission was greatly impressed by the quantity and range of goods which China can offer for export. In addition to cars, British export orders include packing and filling machinery, scientific and electrical instruments, paper-making equipment and some engineering equipment.

FIRST WITH W20

Now BEETLE RESIN* W42

This new synthetic resin core-binder has been specially developed to suit those foundries where fumes and casting odours cause embarrassment. The result of practical co-operation between B.I.P. and leading foundries, Beetle W42 is another example of B.I.P.'s pioneer research and service to the Foundry Industry. W42 has been formulated with the Garrett Report in mind and it possesses all the advantages of Beetle Resin W20, coupled with this important new feature . . .

reduced casting odour

* *Patent Application 32896/58*

B·I·P

Write for technical information to B.I.P. Chemicals Limited, Tat Bank House, Oldbury, Nr. Birmingham

London Office: 1 Argyll Street, W.1. *'Beetle' is a trade mark registered in Great Britain and in most countries of the world.*

Raw Material Markets

Iron and Steel

Production of castings is conditioned by the amount of pig-iron and scrap which can be obtained by the foundries. Most establishments have sufficient work on hand to achieve outputs at capacity levels if the supply of raw materials permitted.

Figures given by the Council of Ironfoundry Associations for outputs of iron castings in 1954 show the extent of the improvement in trade last year, particularly in some branches of the industry, as compared with 1953. During 1954 the total tonnage of castings produced was 3,742,000 tons, which was 2.9 per cent. more than in 1953, deliveries to the motor, tractor, and allied trades being at record levels. The figures would have been even higher if the foundries catering for those trades had been able to secure larger supplies of pig-iron, chiefly in the low- and medium-phosphorus grades. At the light, jobbing, and textile foundries trade was slack for the greater part of the year, resulting in decreased production from those foundries.

Given larger supplies of pig-iron and scrap, most establishments could achieve higher outputs than are at present being obtained. The engineering and speciality foundries are heavily committed; the motor and tractor trades are indenting for large tonnages of castings, and show prospects of an increasing demand in the future, and other trades, including machine-tool makers, power and electrical plant manufacturers, agricultural-implement makers, etc., as well as steelworks and collieries are lending good support.

The overall quantity of the low- and medium-phosphorus irons is inadequate to satisfy all demands, and other irons which can be utilized by these foundries are now in more stringent supply. Hematite producers are fully committed for their outputs; refined-iron makers are also heavily booked, and it is difficult, if not impossible, to obtain an increased supply of pig-iron to fulfil the larger demands for castings which are being made upon the foundries.

A rationing system has had to be devised by most producers of the low- and medium-phosphorus irons and hematite in order to ensure that all users have a fair share of available tonnages.

The increased demand for the high-phosphorus irons absorbs current outputs, and production is taxed to the limit to meet present requirements of the light, jobbing, and textile foundries.

Stocks of all grades of pig-iron both at furnaces and foundries are at a very low level.

Scrap is scarce in most grades, but there is a definite shortage of the heavier and better grades of cast-iron and machinery scrap.

Foundry coke is coming forward fairly satisfactorily and improved transport conditions have eased the delivery position.

The steel industry is uniformly busy.

Non-ferrous Metals

Apart from some fluctuations in copper the tone of the markets last week was steady and tended to be firmer on balance. In zinc the backwardation widened appreciably and the market has again lost all attraction as a hedging medium. In the United States the statistical position has improved, but the price remains at 11¼ cents. Trading in tin is a somewhat humdrum affair, for everyone is awaiting the beginning of the Buffer Pool scheme, which is being held up for some reason.

Other doubts in the tin situation centre round the Texas smelter in the United States, as it is not known whether this will be kept going or not. This question has become something of a hardy annual over the last two or three years, however. There is also the question of stockpiling in the States, for it is felt that 1955 may see the end of special accumulation of tin. Zinc and lead are being stockpiled at an accelerated rate in deference to the producers, who were clamoring for a higher import duty on foreign metal. In copper, the practice still continues, but it is doubtful whether the average monthly additions exceed 10,000 short tons.

Now that the Copperbelt strike has been settled some easing is apparent in the state of tension over supplies and the backwardation narrowed last week to £11 10s. Generally speaking, it would seem that the flow of blister copper is better than at one time seemed probable and possibly the same can be said of electro. Copper prices are firm, for Chile is practically the sole seller of forward metal and she appears to be well sold for the first half of this year. The outlook in electrolytic zinc is not promising; it looks as if we are going to be short of this much needed commodity during the coming months. The premium has already gone up. G.o.b. metal is not scarce, but last week saw gains of 45s. and 15s. in the respective positions and the backwardation widened to £2. On the week, cash copper gained £4 10s. and three months £8. Lead was 15s. up for both positions and tin gained £6 for cash and £5 for three months.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* March 10, £340 to £341; March 11, £343 10s. to £344; March 14, £342 to £343; March 15, £342 to £343; March 16, £344 10s. to £345 10s.

Three Months: March 10, £327 10s. to £328; March 11, £332 to £332 10s.; March 14, £331 10s. to £332; March 15, £332 to £332 10s.; March 16, £335 to £335 10s.

TIN, Standard—*Cash:* March 10, £711 to £712; March 11, £713 to £713 10s.; March 14, £709 10s. to £710; March 15, £708 to £709; March 16, £711 to £712.

Three Months: March 10, £715 to £715 10s.; March 11, £716 to £716 10s.; March 14, £712 10s. to £713 10s.; March 15, £711 10s. to £712; March 16, £713 to £713 10s.

LEAD—*First half March:* March 10, £103 15s. to £104; March 11, £103 10s. to £103 15s.; March 14, £103 15s. to £104; March 15, £103 15s. to £104. *Second half March:* March 16, £104 to £104 5s.

First half June: March 10, £102 15s. to £103; March 11, £102 10s. to £103; March 14, £102 15s. to £103; March 15, £102 15s. to £103. *Second half March:* March 16, £103 to £103 5s.

ZINC—*First half March:* March 10, £88 to £88 10s.; March 11, £89 to £89 5s.; March 14, £89 5s. to £89 15s.; March 15, £88 15s. to £89. *Second half March:* March 16, £89 5s. to £89 10s.

First half June: March 10, £87 to £87 5s.; March 11, £87 5s. to £87 7s. 6d.; March 14, £87 5s. to £87 10s.; March 15, £87 5s. to £87 10s. *Second half June:* March 16, £87 10s. to £87 15s.

New Restrictions on US Scrap

Controls on the export of iron and steel scrap to all countries except Canada and Mexico were tightened by the US Government on Monday.

The new restrictions on export licences have been imposed to prevent excessive drain of domestic supplies caused by heavy industrial activity in Europe, and increased demand in Japan.

WHO USES FULBOND?

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Powell Duffryn House, Adelaide Street, Swansea. Tel. Swansea 4035

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

March 16, 1955

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £15 12s. 0d.; Birmingham, £15 5s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 13s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £18 0s. 3d.

Scotch Iron.—No. 3 foundry, £18 2s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £20 4s. 0d.; South Zone, £20 6s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £21 1s. 6d.; South Zone, £21 4s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £18 2s. 6d.; Scotland (Scotch iron), £18 9s. 0d.; Sheffield, £19 7s. 6d.; Birmingham, £19 14s. 6d.; Wales (Welsh iron), £18 9s. 0d.

Basic Pig-iron.—£15 15s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots).—40/55 per cent., £40 15s. 0d., basis 45 per cent. Si, scale 15s. per unit; 70/84 per cent., £63 0s. 0d., basis 75 per cent. Si, scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £161 0s. 0d. to £165 0s. 0d. per ton; 38/40 per cent., £258 0s. 0d. to £262 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 17s. 0d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 0d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £78 0s. 0d. to £80 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £76 0s. 0d. to £78 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 8½d. per lb. Cr; 1 per cent. C,* 1s. 9d. per lb. Cr; 0.15 per cent. C,* 1s. 10½d. per lb. Cr; 0.10 per cent. C,* 1s. 11d. to 2s. 2d. per lb. Cr; 0.06 per cent. C,* 2s. 0d. to 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 6½d. to 7s. 1d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £54 15s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 5s. 0d.; tested, 0.08 to 0.25 per cent. C, £26 5s. 0d.; hard (0.41 to 0.60 per cent. C), £27 10s. 0d.; silico-manganese, £34 10s. 0d.; free-cutting, £29 6s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 17s. 0d.; silico-manganese, £34 10s. 0d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 15s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £33 11s. 6d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 19s. 6d.; flats, 5 in. wide and under, £31 19s. 6d.; hoop and strip, £33 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £34 5s. 0d.; black sheets (hand mill), 17/20 g., £43 13s. 6d.; galvanized corrugated sheets, 24 g., £55 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £54 7s. 9d.; nickel-chrome, £76 7s. 9d.; nickel-chrome-molybdenum, £86 8s. 6d.

NON-FERROUS METALS

Copper.—Cash, £344 10s. 0d. to £345 10s. 0d.; three months, £335 0s. 0d. to £335 10s. 0d.; settlement, £345 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 3½d. per lb.; rods, 385s. 3d. per cwt. basis; 20 s.w.g., 416s. 6d. per cwt.

Tin.—Cash, £711 0s. 0d. to £712 0s. 0d.; three months, £713 0s. 0d. to £713 10s. 0d.; settlement, £712 0s. 0d.

Lead (Refined Pig).—Second half March, £104 0s. 0d. to £104 5s. 0d.; second half June, £103 0s. 0d. to £103 5s. 0d.

Zinc.—Second half March, £89 5s. 0d. to £89 10s. 0d.; second half June, £87 10s. 0d. to £87 15s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £120 0s. 0d.; rolled zinc (boiler plates), all English destinations, £117 15s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 7d. per lb.; rods, drawn, 3s. 4½d.; sheets to 10 w.g., 335s. 3d. per cwt.; wire, 3s. 2½d.; rolled metal, 321s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £214; B6 (85/15), £302; BS249, £238.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £261; HTB2 (38 tons), £277; HTB3 (48 tons), £287.

Gunmetal.—RCH, 3/4 per cent. tin, —; BS1400, LG2 (85/5/5/5), £283; LG3 (86/7/5/2), £297; G1 (88/10/2/), £372; (88/10/2/1), £362.

Phosphor Bronze.—BS1400, PB1 (AID released), £382 per ton.

Phosphor Bronze Strip, etc.—Strip, 468s. 9d. per cwt.; sheets to 10 w.g., 492s. 3d. per cwt.; wire, 4s. 9½d. per lb.; rods, 4s. 2½d.; tubes, 4s. 0½d.; chill cast bars: solids 4s. 1d., cored 4s. 2d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 5d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 4d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £109 0s. 0d. to £109 10s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £103 0s. 0d.; aluminium bronze (BS1400), AB1, £332; AB2, £343. Solder, brazing, BS1845, 2s. 6d. lb.; granulated, 2s. 9d. lb.

* Average 68-70 per cent.